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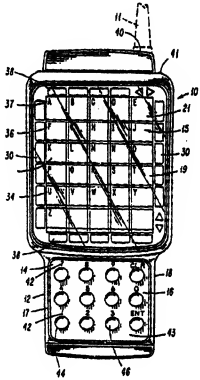
(54) Title: PORTABLE WORK STATION AND DATA COLLECTION TERMINAL INCLUDING SWITCHABLE MULTI-PURPOSE TOUCH SCREEN DISPLAY

(57) Abstract

A portable data collection terminal (10) has an elongate housing (12) with a hand grip conforming rear surface. A front surface (14) features a numerical keyboard (16) adjacent a lower end of the housing and an LCD screen (15) adjacent the keyboard toward an upper end of the housing. The display screen is of elongate rectangular shape, its length extending longitudinally of the housing of the data terminal. The active area of the display screen is covered by a touch sensitive overlay screen which is configured in one mode of operation of the data terminal into an alphabetical keyboard. The orientation of the display is switchable between orientations in which the line direction of the displayed data extends across or longitudinally of the data terminal. The keys (46), of the numerical keyboard (16) are identified by indicia (42) disposed on a template (13). The orientation of the template may be sensed to switch the orientation of the displayed data and touch sensitive key identifiers to correspond to the orientation of the indicia on the template. As a further embodiment an electromagnetic activation by a pen may be used to enter data into a data terminal. Power saving shutdown extends the battery life of the data terminal. A shutdown mode permits resumption of operations by depression of a key.



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TITLE: PORTABLE WORK STATION AND DATA COLLECTION TERMINAL INCLUDING SWITCHABLE MULTI - PURPOSE TOUCH SCREEN DISPLAY

CROSS REFERENCE TO RELATED APPLICATIONS
(Claiming Benefit Under 35 U.S.C. 120)

This application is a continuation-in-part of co-pending application U.S. Serial No. 08/048,873, filed April 16, 1993, which is a continuation of application U.S. Serial No. 07/948,034, filed September 21, 1992, by Phillip Miller et al., which is a continuation of U.S. Serial No.

07/347,602, filed May 3, 1989, by Phillip Miller et al., now abandoned, and a continuation-in-part of co-pending application U.S. Serial No. 08/023,840, filed February 26, 1993, by Arvin D. Danielson, Darrell L. Boatwright, Darald R. Schultz, Rickey G. Austin, and Dennis Silva, which is a continuation-in-part of U.S. Serial No. 07/728,667, filed July 11, 1991, by Arvin D. Danielson, Darrell L. Boatwright and Darald R. Schultz.

Reference is also made to the following related application U.S. Serial No. 08/005,324, filed January 15, 1993, by George E. Chadima Jr. et al., which is a continuation of U.S. Serial No. 07/549,298, filed July 5, 1990, now U.S. Patent No. 5,180,232, which is a continuation-in-part of U.S. Serial No. 07/216,868, filed July 8, 1988, now U.S. Patent Des.315,573, and a continuation-in-part of U.S. Serial No. 07/227,195, filed August 2, 1988, now abandoned, and a continuation-in-part of U.S. Serial No. 07/347,602, filed May 3, 1989, now abandoned, which is a continuation-in-part of U.S. Serial No. 07/346,771, filed May 2, 1989, now abandoned.

BACKGROUND OF THE INVENTION

The invention relates generally to data collection and processing systems and to portable data terminals thereof. In particular, the invention relates to data input and output arrangements and to data display and verification.

Portable data terminals are well known components of state of the art business systems. The data terminals may be taken to merchandise storage facilities for inventory control or customer service transactions, or may be used in any one of various other commercial applications to serve as data input or output devices for central data processing and control stations.

It appears that operations and usefulness of such central data processing or control stations are enhanced with efficient and prompt data entry and retrieval at the working level. Most efficiently data entry and retrieval may be obtained through a plurality of portable data terminals which selectively become coupled to the central processing or control stations. Operator controlled data interchange may be established between central stations and the portable data terminals.

Increased versatility in data input and output arrangements tends to increase power usage of the portable data terminals, thereby decreasing usage periods between battery exchanges or recharging operations. Touch sensitive or pen actuated data input systems are known. Use of pen actuated data entry systems in hand held, portable data terminals has been limited in the past in part because of power management limitations, partly because of problems relating system compactness, and also partly because of problems relating to terminal limitations when an otherwise practical pen-type data entry is provided as a

sole or main data acquisition mode for a portable data terminal.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide an improved data input and display with increased functionality.

It is another object of the invention to arrange an alphanumeric keyboard for multi orientational use.

Further in accordance herewith it is an object of the invention to provide a pen-activated data input device which interactively may be prompted through display screen prompts.

Another object of the invention is to provide a robust data terminal having a display screen sized to permit operator input via pen strokes and having the capability to change to keyboard entries interchangeably with entry via pen-type signals.

Yet another object of the invention is a power management control function implemented through software controlled microprocessor functions, the power management function including selectively shutting the data terminal down without loss of current data interchange status states on an Input-Output bus (I/O Bus).

According one aspect of the invention, it is consequently contemplated to increase the data input capacity of a portable data terminal with a touch sensitive liquid crystal display which functions as an extended keyboard and as a provision for entering graphic data such as signatures. Another keyboard may be a numerical keyboard or may be activated as a function keyboard to supplement a touch sensitive keyboard implemented as an overlay of a display screen.

In an embodiment in accordance with the invention, keys of the touch sensitive keyboard of the display screen of the portable data terminal are selectively re-orientable with respect to the

data terminal. In accordance with a particular feature of the invention, the keys or key areas of the touch sensitive keyboard are reoriented by switching key assignment areas within the touch sensitive display screen and by reorienting indicia within each of the switched touch sensitive areas of the board to change the orientation of the indicia to correspond to a change orientation of the keyboard of the touch sensitive area.

Further in accordance with the invention, a keyboard is disposed adjacent a display screen of a portable data terminal in a frontal face of the data terminal. The keyboard includes an array of keys, each key having an assigned function, and an array of indicia identifying the function of each of the keys of the array. The array of indicia is disposed on a matrix removably attachable to the frontal face of the data terminal. The array of indicia may be removed and replaced by another array of indicia, showing reassigned functions of each of the keys, and the functions of the respective keys are reassigned in accordance with such other array of indicia.

In a particular embodiment of the invention, the array of indicia is displayed on a sheet of material which may be attached as an overlay to the area of the keyboard in one of at least two distinct orientations, and the assignment of the functions of the keys may be switched to correspond to a reorientation of the switched sheet of indicia.

Also according to the present invention, a data terminal has a display screen and graphic data input surface coincident with and disposed beneath the display screen. Data input into the graphic data input surface is obtained via an electromagnetic pen.

Further in accordance herewith, the data terminal includes operation shadowing circuits which include a function of shadowing Input-Output (I/O) device states and a function of storing microprocessor register states during a shutdown procedure. Pursuant to the shadowing and microprocessor register storage, the data terminal may be shut down and re-activated without loss of control or I/O status data and with the ability to complete an operation in progress during the time of shutdown of the data terminal.

Further in accordance herewith, a data terminal includes a shock and weather resistant housing and a keyboard orientation with respect to a display screen which causes an included angle to protect both the keyboard and the display screen from contact with a flat hard bottom surface during a fall of the data terminal against such surface. Co-molding of shock absorbing material to the surface of the housing distributes impact forces to which the data terminal may be exposed as a result of a fall. Co-molded sealing strip disposed on access covers provide a weather-sealed housing while further enhancing impact resistance of the data terminal.

A removable base plate includes a co-molded weather seal which also provides impact resistance. A particular base plate or base includes an accessory pod which is centrally disposed along a central axis of a housing of the data terminal. The accessory pod has a width transverse to the longitudinal axis which is less than the transverse width of the data terminal, the accessory pod including a handgrip portion by which an operator may hold the data terminal while operating the data terminal.

The base is exchangeable for any of a number of other bases, each base having a particular one

of a number of desirable accessory features. At least one of the bases is contemplated to include a scanner for reading indicia which may be disposed on a surface external and separate from the data terminal. The scanner may, for example, be a bar code scanner. The data terminal may feature two hand strap provisions disposed externally of the housing. An operator may insert fingers or a portion of the hand between the housing and one of the handstrap provisions to retain the unit by friction between the hand and the strap.

Various other features and advantages of the invention will become apparent when the detailed description below is read in reference to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description refers numerically to elements of the drawings wherein:

FIG. 1 is a frontal view of a data terminal showing a touch sensitive display screen in combination with a keyboard in accordance with an embodiment of the present invention;

FIG. 2 is a schematic frontal view of the data terminal of FIG. 1 showing a preferred overlay for a keyboard of the data terminal;

FIG. 3 is a similar schematic frontal view as in FIG. 2, with the overlay shown in a reoriented position with respect to the position of that shown in FIG. 2 relative to the data terminal;

FIG. 4 shows yet a further orientation of the keyboard and the overlay which may be desired in accordance with the invention; and

FIG. 5 shows a further orientation of the keyboard and overlay in accordance with the invention;

FIG. 6 is a side view of the data terminal shown in an upright position as in FIG. 1 and showing frontal and rear shells of a housing of the data terminal;

FIG. 7 is a simplified schematic diagram of the data terminal showing basic functional elements of the data terminal in FIG. 1;

FIG. 8 is a frontal view of the data terminal shown in FIG. 1, and further modified with a scanner module, such as a laser scanner module for reading bar codes;

FIG. 9 is a frontal view of the data terminal shown in FIG. 1, showing in an alternative embodiment an attachable grip portion attached to a lowermost end of the longitudinal housing of the data terminal;

FIGS. 10 and 11 depict tab positions of a keyboard template structure as an alternative to the structure shown in FIG. 2;

FIG. 12 is a simplified representation of a data terminal system including a data input screen and keyboard combination in accordance with the invention;

FIG. 13 is a pictorial representation of the data terminal shown in FIG. 12 showing an accessory pod of the data terminal;

FIG. 14 is a sequence chart of an assembly process in accordance herewith;

FIGS. 15 and 16 illustrate features involved in a co-molding process;

FIG. 17 shows details of a battery compartment access door;

FIG. 18 is a diagram of electronic functions of one embodiment of the data terminal in accordance with the invention;

FIG. 19 is a diagram of electronic functions of a modified embodiment of the data terminal showing further details in accordance with the invention;

FIG. 20 is a diagram of electronic functions of an input-output function board which may be coupled to an input-output function connector shown in FIG. 19, for example;

FIG. 21 is a control logic flow diagram of a sequence that be followed during power up or power down operations of a data terminal according to the invention;

FIGS. 22, 23 and 24 show schematically simplified an end view, a top view of an upper end, and a cut through the upper end of a modification of a data terminal shown in FIG. 12;

FIG. 25 is a pictorial representation of the data terminal, showing a frontal face thereof;

FIG. 26 is a partial bottom view of the data terminal shown in FIG. 25;

FIG. 27 is a diagram of electronic functions of the data terminal shown in FIGS. 12, 13 and 25, showing preferred modifications that may be made within the scope of the invention over the functions described with respect to FIG. 19; and

FIG. 28 is a diagram showing contemplated functions which may be executed by a communications interface circuit shown in FIGS. 18, 19 and 27.

DETAILED DESCRIPTION OF THE INVENTION

In reference to FIG. 1, there is shown a frontal view of a portable data collection terminal or data terminal which is designated generally by the numeral 10. The data collection terminal 10 is a hand-held, portable unit, which is understood in the art as being powered by a self-contained power source. Such a portable data terminal 10 may operate in what is referred to as a batch mode in which data are collected by and stored within the data terminal 10 to be transferred to an alternate data processing unit or host computer (not shown) in a comprehensive "batch" type operation. In the alternative, the data terminal 10 may be in communication with such a host computer in an interactive or on-line mode via a data communications link, such as a radio frequency transceiver arrangement. The presence of such a radio transceiver is indicated as an alternative embodiment by a radio antenna 11, shown in phantom lines as the only externally visible element of such a transceiver. An elongate housing 12 preferably of a high-impact-strength plastic material encases the data terminal 10. Various types of materials are known and are commercially available.

The housing 12 of the data terminal 10 features a front surface 14. A display screen 15 is attached to the front surface 14 and may occupy a major portion of such front surface. A keyboard 16 is disposed adjacent the display screen 15. The display screen 15 is desirably a liquid crystal display screen ("LCD screen"). State of the art LCD screens generally employ "double super twist" technology which has been found to provide satisfactory viewing contrast under most direct lighting conditions. It is further possible to provide backlighting for LCD screens. However,

power considerations may require selective disablement or even deletion of backlighting. As is apparent from FIG. 1, with respect to the housing 12, the LCD screen 15 is of a comparatively large size, a lateral overall width of the LCD screen 15 extending over general lateral boundaries 17 and 18 of the elongate shape of the housing 12. The longitudinal extent of the display screen also occupies a major portion of the front surface 14 of the data terminal 10. The keyboard 16, being limited in size by the available area on the front surface 14, consequently, would function primarily as a "numerical" keyboard, such as for numeric data entry.

An active display area 19 of the display screen 15 may be of a preferred minimum area of approximately 80 X 120 millimeters. The active area 19 is preferably a "bit-mapped" display, meaning that the display is comprised of an array or matrix of individually addressable display elements 21, and each such element or pixel 21, a representative location of which being referenced in FIG. 1, is driven by a data state of a particular individually addressable location in a memory 22 (shown schematically in FIG. 6) of the data terminal 10. It is further found desirable that memory locations which control the activation of respective ones of the pixels 21 of the display screen 15 encompass more than single memory cells, such that more than a simple on-off function, but rather a gray scale value may stored in each dedicated group of cells of the memory 22 to be applied to the particularly addressed pixel 21.

Because of the electrical connections for implementing the display screen functions, the display screen 15 includes a boundary area 31 which extends beyond the lateral confines of the

housing 12 of the data terminal 10. Because of the desirably large active screen area 19, for the display information compatible with that on a standard computer screen, for example, the minimum desirable size of the display screen 15 tends to conflict with a design intent to maintain an overall size of the data terminal 10 as small as possible. In that the enlarged screen area of the data terminal 10 occupies a substantial part of the front surface 14 of the housing 12, the front surface 14 seemingly lacks the frontal surface area to accommodate both the numeric keyboard 16 and an alphabetical keyboard in addition to the display screen 15.

In overcoming space restraints on the front surface 14, the display screen 15 is ideally provided with a touch sensitive active surface area 32 as an overlay to the LCD screen for use as a keyboard. The touch sensitive active surface area 32 may be implemented in a currently preferred embodiment by known technologies which employ, for example, either capacitive or resistive switching and sampling techniques to determine coordinates of a point on the surface area 32 against which a contact pressure is exerted. The overlay area 32 is essentially transparent, such that information displayed on the screen 15 remains clearly discernible. For example, the touch sensitive active area 32 may selectively be configured as a keyboard for manual input of alphabetical characters. In the preferred embodiment the size of the touch sensitive overlay area 32 corresponds to active display area 19 of the LCD screen 15. It should be noted, however, that such choice is one of convenience, and that less than the active display area 19 of the display screen 15 may be encompassed by the touch sensitive active area 32.

A keyboard array 34 of active key areas 36 may be displayed on the display screen 15 to correspond to the assigned key areas 36. Each of the key areas forms a discrete functional unit, in that a touch or pressure in any or all portions of such discrete area 36 results in one and the same input signal being generated. Indicia 37 of letters or of control functions also may be displayed directly beneath the respective active key areas 36 of the array 34 on the screen 15. The indicia 37 correspond to and identify input signals generated in response to contacts being made in such designated key areas 36. The display of the keyboard array 34 and of the indicia 37 is desirably selectively activated whenever keyboard entries are to be made via the touch sensitive key areas 36. Also, it may be desired to alternate between a display of data as feedback of data entered and the display of the keyboard array 36. In a further variation of the described embodiment it is contemplated to deactivate the touch sensitive active area during periods in which the display screen 15 is used entirely for data display. Another advantage of the bit-mapped display screen 15 and the correspondingly identifiable touch sensitive area 32 is that graphic data displaying a customer invoice may have a designated area, selectively activated, for receiving a signature as acknowledgement by a customer. The signature is stored in memory and may be recalled and reproduced on paper copies of the invoice by a central processing station. If all other areas displaying invoice information are deactivated, so as not to receive a touch sensitive input, no changes can be made at the time the acknowledgement is requested. The use of alphanumerical data collection is further advanced by character recognition algorithms for processing

and storing actual data in response to hand-produced inputs to the screen. For example, the display may provide line spacings as guides for receiving written characters. Within such designated boundaries a sensed pattern of graphic inputs is compared to a character of information. The apparently matching character is displayed. The display is an immediate feedback as to whether the correct character has been recognized. If an incorrect character appears, a graphic correction is made as a deviation with respect to the displayed character. Various other advantages will appear from the further description of the preferred embodiment of the invention.

Touch sensitive screens require electrical couplings to be made along horizontal and vertical peripheral borders 38 and 39 of the display screen 15. Such electrical couplings are space consuming and need to be made in addition to bit-mapped display screen connections, which are also made along the peripheral borders 38 and 39. All of such connection regions constitute inactive areas of the screen 15. Preferably, to make optimum use of inactive horizontal and vertical connection areas adjacent the active area of the display screen 15 are used for displaying permanently imprinted information, such as grid indicators 40 and cursor indicators 41. The peripherally displayed information helps in delineating the keyboard area 34 with respect to the display screen 15. In further reference to FIG. 1, the active area 19 of the display screen 15 desirably is of elongate configuration, thereby minimizing the lateral projection of the display screen 15 beyond the lateral boundaries 17 and 18 of the housing 12. However, because of size of the display screen being greater in the vertical direction of the data terminal 10, it appears

desirable to display long lines of data in the longitudinal direction of the screen, hence perpendicular to the direction in which data might normally be displayed on the screen 15.

Adjacent the display screen 15, the remaining portion of the front surface 14 of the data terminal 10 is occupied by the numerical keyboard 16. According to a preferred embodiment of the invention, indicia 42 identifying the numerals or functions of the numerical keyboard 16 are disposed on a template 43. The template 43 is a flat sheet of material which features a plurality of apertures 44 to correspond in size and location to the size and location of keys 46 arranged in a preferred "3 X 4" array 47. The template 43 consequently fits over the keys 46 and rests when attached to the keyboard 16 adjacent and in contact with a base surface 48 of the keyboard 16. In the example of the keyboard 16 shown in FIG. 1 the keys 46 protrude through the base surface 48 and similarly through the template 43. As shown the keys 46 are circular in their plan view. It should be understood that keys of other shapes, for example, square keys or even rectangular keys may arranged as the circular keys 46 and marked with indicia disposed on the template 43 as described herein.

The template 43 is preferably removably attached to the base surface 48 which may be part of the front surface 14 of the housing 12. Consistent with a desirable alternate orientation for displaying data characters in lines on the display screen 15 longitudinally with respect to the data terminal 10, it appears to be advantageous to reorient the indicia 42 on the template 43 with respect to the data terminal 10 when information displayed on the screen becomes reoriented with respect to the data terminal.

FIGS. 2 through 5 show in a simplified representation of the data terminal 10 various orientations of the template 43 with a correspondingly physical reorientation of the indicia and alternate orientations of the keyboard 16. In FIG. 2, the template 43 is shown in a first position, in which the indicia 42 disposed on a first major surface 49 of the template 43 are oriented to be read when the data terminal is operated with the keyboard 16 disposed below the display screen 15 or more closely disposed toward an operator than the screen 15 when the data terminal 10 is held by the operator in a common operating position. In such a position, lines 50 of data would be displayed on the screen 15 in a left-to-right position across the width of the data terminal 10, or in parallel with, hence, non-intersecting with the keyboard 16.

In FIG. 3, a second set of indicia 51 is displayed on a second major surface 52 or flip side of the template 43, the template 43 being thus reversible and having been reversed. On the second major surface 52, the second set of indicia 51 is oriented to identify the functions of the keys 46 at right angles to the orientation of the original set of indicia 42. Thus, data displayed on the display screen 15 correspondingly would be shifted by ninety degrees from their original orientation on the display screen 15, allowing a longitudinal display line 54 and, hence, permitting more characters in each line 54 of display. The correspondingly reoriented set of indicia 51 on the template 43 permits the keyboard 16 to be read by an operator reading data on the screen 15 without a need for the operator to transpose numbers or functions being shown on the template 43. This latter orientation of the displayed data and the set of indicia 51 is

mutually coextensive, such that line extensions of the displayed data would intersect the keyboard 16.

In reference to both FIGS. 2 and 3, by transposing the orientation of the keyboard 16, a numerical assignment of at least a major pattern of the keys 46 is preferably also transposed to maintain keystroke patterns to which operators of the data terminal 10 may be accustomed. In a preferred embodiment a reassignment of the functions of the keys 46 would be performed simultaneously with a reassignment of functions of the key areas 36 of the touch sensitive keyboard array 34 and with a reorientation of the display on the display screen 15. FIGS. 2 and 3 are shown with both lines 50 and 54 of data in part of the display screen 15, and with keyboard areas 36 in another part of the screen 15 to illustrate the simultaneous reorientation of the data display and the keyboard array 34 and its assigned touch sensitive key areas 36.

The change in orientation of the display and the corresponding reassignment of the keys 46 and key areas 36 may be originated by operating a switch, by a keystroke operation of one or a combination of the keys 46 or of one or a combination of the key areas 36 which define the keyboard array 34 of the touch sensitive screen 32. It is to be realized that orienting the template 43 is, in the described embodiment, a physical function that would be performed by an operator of the data terminal 10. A simplifying step seeks to combine the physical reorientation of the template 43 with functional switching or reorientation of the keys 46, the key areas 36 and the display screen 15.

Accordingly, the template 43 may be adapted to become attached to the front surface 14 of the

data terminal 10 in a reoriented position and simultaneously therewith a reorientation of the display screen 15 and the touch sensitive keyboard array 34 may be initiated. FIG. 2 shows a plurality of peripheral tabs 61, 62, 63, 64 and 65. The positions of the tabs 61 through 65 along respective edges 66, 67, 68 and 69 of the template 43 correspond generally to positions of representative sensors 70 and 71 disposed in recesses 72 and 73, for example, of six representative peripheral recesses 72 through 77 for retaining the template 43. The tabs consequently serve a dual function of physically seating the template 43 in its position, and of selectively engaging or activating one or more the sensors 70 and 71, such that by such selective activation the orientation of the template 43 is determined by the data terminal 10. The sensors 70 and 71 and the recesses to receive the tabs may be disposed in housing ridges 78, 79, 80 and 81 disposed peripherally about the keyboard 16. The sensors 70 and 71 may be electrical sensors of a direct contact type, such as electrically conductive pads which may be bridged by electrically conductive strips disposed on the template 43. Typical bounce suppression circuits may be used to eliminate false signals due to contact bounce and establish a reliable, switched electrical connection when predetermined ones of the contact pads of the sensors 70 and 71 are bridged upon attachment of the template 43 to the front surface 14 with a selected orientation. As another alternative embodiment, the sensors 70 and 71 may be magnetic sensors.

In a described, currently preferred embodiment, instead of being magnetic type sensors or electrical contacts, the sensors 70 and 71 are described as being photoelectric sensing cells.

When the tabs 61-65 are inserted into respective recesses, photoelectric sensing by the sensors 70 and 71 would be selectively affected in accordance with the orientation of the template 43. In reference to FIG. 11, a selected area on an upper underside 95 of a respective recess may be reflectively coated to redirect light from a source 96, such as a light emitting diode, disposed adjacent an optical sensor 97, such as a photo sensitive diode. When the template 43 is attached to the keyboard 16 with an orientation in which a respective one of the tabs interrupts the light path between the light emitting diode 96 and the photo diode 97, an appropriate orientation of the template is recognized by a respective sensing circuit 100. The recognition of the orientation of the template 43 accordingly may be used to reassign the key areas 36 of the keyboard array 34 and the keys 46 of the keyboard 16 as well as reorient data shown on the display screen 15.

In further reference to FIGS. 2 through 5, the simplified representations of the data terminal 10 show schematically indicated recesses 72 and 75 along the lateral boundary of the housing 12. The tabs 61 and 62 are disposed adjacent one another along the edge 66 and are symmetrically disposed with respect to a center point of the edge 66. The recesses 72 and 75 are of equal length and are centered on the keyboard 16. The overall length of the adjacent tabs 61 and 62 including a gap 112 is the same as the length of the single tab 64 on the opposite edge 68 of the template 43. The tab 64 is also centered along its edge 68. Thus, whether the template 43 is rotated 180 degrees in a plane parallel to the plane of the front surface 14, or whether the template 43 is flipped over about an axis 114 of rotation parallel to a longitudinal

axis through the data terminal 10, the tabs 61 and 62 will be received by one of the recesses 72 or 75, while the single opposite tab 64 will be received by the other recess 72 or 75.

In the described embodiment, in each of the top and bottom ridges 79 and 81, respectively, there are two recesses 73, 74 in the top ridge 79 and 76, 77 in the bottom ridge 81, respectively. The recesses in each of the respective ridges 79 or 81 are symmetrically offset from the central axis 114. The tabs 63 and 65 would be similarly offset with respect to the central longitudinal axis through the template 43 such that each of the tabs 63, 65 occupy one of the recesses 73, 74, 76, 77, depending on the orientation of the template 43. The sensor 71 is, for example, disposed in the top recess 73. The chosen recess 73 is not critical for the recognition of the orientation of the template 43, in that any other one of the recesses 73, 74, 76 and 77 may be chosen to achieve a desired recognition of the orientation as described herein. Other changes in configuring the template 43 with corresponding changes in the recesses are, of course also possible within the scope of the invention.

For example, in reference to FIGS. 2, 10 and 11, the tabs 63 and 65 of the template 43 may be disposed across the central axis 114, yet somewhat offset with respect thereto. As an example, a tab 121 is shown in FIG. 10, in which the tab 121 of an alternately configured template 122, extends into a single bottom (or top) recess 123. The recess 123 is longer than the length of the tab 121 by substantially one-half of the offset of the tab 121 with respect to the centerline or central axis 114. A sensor 124 is located at one end of the recess 123. Thus, when the tab 121 is inserted into the respective recess 123, the

sensor 124 will be covered when one major surface of the template 122 is facing up, but will not be affected when the template is flipped over about the central axis 114. Of course, two complementary tabs on opposite edges of the template would be required comparably positioned with identical offsets with respect to the central axis 114 to obtain similar orientation indications of the template as described with respect to FIGS. 2 through 5.

Referring again to FIGS. 2 through 5, it should be noted that the sensors 70 and 71 have unique combinations of binary states of being unaffected or affected by an intervening one of the tabs to distinguish between the four different desired orientations of the template 43. FIG. 2, showing the data terminal 10 in a "normal, upright" position with the numerical keyboard 16 below the display screen 15 and the data lines 50 reading across the width of the data terminal 10, the sensor 70 is unaffected or normal, and the sensor 71 is affected by the tab 63. It should be noted that in the configuration of the template 43, the function of the tabs 61 and 62 is to affect the retention of the template in the respective recess 72 or 75.

In FIG. 2, the template has been flipped over about a longitudinal axis, such that its second major surface 52 is exposed. In this orientation an operator would view the data terminal 10 with the keyboard 16 toward the left. In such orientation of the template 43, the sensor 70 is affected by the tab 64. The sensor 71 is now uncovered and unaffected by any of the tabs, in that by flipping the template 43 over as described the tab 63 which previously covered the sensor 71 has been transposed to occupy the tab position in the symmetrically adjacent recess 74 (with respect

to the axis 114 as an axis of symmetry). It should be noted that in this orientation of the data terminal 10 the display screen 15 allows more characters of information to be displayed in the longer data lines 54. At the same time, the numerical keyboard 16 and the alphabetical keyboard array 34 are now laterally adjacent with respect to each other. While such lateral orientation permits more data to be displayed in a single display line 54, the orientation is distinct in that the numerical entry keyboard 16 would be more easily accessible by a left handed operator than by a right handed operator, while the touch sensitive alphabetical keyboard array 34 as an overlay to the display screen 15 would be more accessible to a right handed operator than the keyboard 16. Thus, in operational modes in which the longitudinal display lines 54 are preferred, and depending on whether the numerical or the alphabetical keys see more use, an operator may prefer to have the keyboard 16 on the left hand of the data terminal or on the right hand.

The latter mode, in which a longitudinal data display is oriented to place the keyboard 16 on the right hand side as an operator would face the data terminal 10, is shown in FIG. 4. The orientation of the template in FIG. 4 is uniquely identified by the states of the sensors 70 and 71. The sensor 70 is unaffected being straddled by the two tabs 61 and 62, and the sensor 71 remains uncovered in that the positions covered by the tabs 63 and 65 are not affected by a 180 degree rotation of the template 43 in a plane parallel to the plane of the keyboard 16.

FIG. 5 shows a fourth arrangement of the template 43 in accordance with the orientation of which the indicia of the template are inverted with respect to the normal or starting orientation

of the indicia shown in FIG. 2. The orientation of the template 43 as shown in FIG. 5 might be used when the alphabetical keyboard array 34 is favored over the numerical keyboard 16. Placing the numerical keyboard 16 at the top of the data terminal 10 decreases interference with the use of the alphabetical keyboard array 34. In the orientation of the template 43 as shown in FIG. 5, both sensors 70 and 71 are activated, the sensors 70 and 71 indicating the presence of the tabs 64 and 65, respectively.

Since each of the four orientations of the template 43 are associated with a particular combination of states of the sensors 70 and 71, the state of the sensors is preferably used correspondingly reorient the displayed data on the screen 15. With respect to the above description of the position of the tabs, it must be kept in mind that the positions of the tabs of the template 43 are of choice and are assigned for illustrative purposes only. Thus, it may be desirable to assign the positions of the tabs shown in FIG. 4 to the orientation of the indicia 42 as shown in FIG. 2. The advantage of such orientation is that if the orientation of the indicia 42 in FIG. 2 is to be a default orientation, then the removal of the template 43 would render the state of the activation of the sensors 70 and 71 to be the same as the orientation of the template 42 in such default orientation. The arrangement of the tabs of the template 43 as described above in detail might be preferred when the longitudinal orientation of the display shown in FIG. 4 is the default orientation of displayed data. In a particularly contemplated embodiment it may be preferred to place indicia, oriented in accordance with the default orientation, on the base surface 48 of the

keyboard 16 to identify the function of the keys 46 in their default orientation when the template 43 is removed from its place adjacent the base surface 48.

There are a number of contemplated electronic switching modes by which the orientation of displayed data on the display screen 15 may be made to correspond to the orientation of the indicia of the template 43. For example, it may be desirable to normally retain the sensors 70 and 71 and any corresponding switching circuits inactive. Thus, unless activated, the sensors 70 and 71 and respective circuits would not place a drain on the self contained power source of the data terminal 10. In response to a simultaneous depression of a combination of keys, for example, the "1" and "3" key of the current orientation, the sensors 70 and 71 may become activated for a predetermined period of time. The time period may, for example, be set to keep the sensors active for three minutes. During the three-minute period, the sensors may further be timed to perform a predetermined number of "sample sensing operations", such as one sample every ten or fifteen seconds until the period of three minutes has lapsed. At that time the selective sampling would cease until the desired combination of the keys 46 is again depressed. During such period of activation, the orientation of the display of data on the display screen and, of course, the orientation of the indicia of the touch sensitive keyboard array 34 would be switched in accordance to the indication obtained by the sensors 70 and 71. For example, when the combination of the keys "1" and "3" is held down simultaneously, a first sampling by the activation of the sensors 70 and 71 may still indicate the same state of the sensors as would be expected with the most recent

orientation, in that the orientation of the template 43 has at that time not been changed. A second sampling by the sensors 70 and 71 may occur during the time when the template 43 has just been removed. At that time neither of the sensors would detect one of the tabs and the data display of the display screen 15 is switched to the default orientation, either as shown in FIG. 4, or any other default condition as may have been provided in accordance with the description hereof. A third sampling by the sensors 70 and 71 may occur when the template 43 has been attached to the keyboard 16 in its desired reoriented position. The displayed data on the display screen 15 would at this time shift to the new orientation and the functions of the keys 46 of the keyboard 16 would also be reassigned in accordance with the new orientation. Provided the template 43 is not reoriented further during the remaining active sampling period, further samples taken by the sensors 70 and 71 would simply retain the present orientation until at the end of the predetermined sampling period further sampling ceases. However, while the sampling period is still running, the template 43 may be switched again to another orientation. The next following sample of the orientation by the sensors 70 and 71 then again aligns the orientation of the data display with the orientation of the template 43. It should be understood, however, that the above functional description of a means and method for orienting the physical keyboard 16, the keyboard array 34 and the display with respect to each other is simply one example of implementing the invention in accordance herewith.

In reference to FIG. 6, physical external details of the data terminal 10 are shown in a side view thereof to illustrate particular

handling features relative to the described reorientation of the displays. In a preferred embodiment, the housing 12 of the data terminal 10 features a frontal shell 130 including the described features of the display screen 15 and the keyboard 16, and a rear shell 131. The rear shell 131 desirably may correspond dimensionally and functionally to the rear shell of a known and currently available data terminal marketed by the assignee of the present invention. It appears that the features as will be described in greater detail below of such currently existing housing shell are of advantage in combination with the present invention. The rear shell 131 includes a grip portion 133 which is formed by a contoured indentation 134 deviating from a generally rectangular shape of the data terminal 10. The inwardly formed grip-conforming surfaces 135 of the indentation 134 may in a preferred embodiment be spanned by a hand strap 136, ends 137 and 138 of which being attached adjacent, respectively, upper and lower ends 139 and 140 of the rear housing shell 131. The grip-conforming surfaces 135 on each side of the rear housing shell 131 taper rearwardly toward each other to more readily conform to a user's hand. The hand strap 136 is in the preferred implementation of a width less than the width of the data terminal 10. Nevertheless, the hand strap 136 is of a width to firmly retain the user's hand against the contoured grip portion 133, even when the hand grip momentarily becomes relaxed. The data terminal 10 is readily grasped and held with one hand, either the left hand or the right hand of an operator, allowing the other hand of the operator the freedom to manipulate the keyboard 16 or the keyboard array 34 on the front surface of the data terminal. When the operator's hand is slipped

between the hand strap 136 and the rear shell of the housing the data terminal may be held in a first or upright position, in which the lower end 140 of the data terminal 10 is directed toward the operator, while the upper end 139 faces away from the operator. It is apparent, that the hand strap is advantageously used to also hold the data terminal 10 in a second or lateral position at substantially right angles to such an upright position by turning the wrist of the hand that is holding the data terminal 10. For example, a person may be holding the data terminal by the left hand in the upright position as shown in FIG. 2, for example. A twist of the wrist in a counterclockwise direction places the data terminal 10 into a lateral position with respect to the person holding the data terminal, in which a reoriented position of the indicia would desirably correspond to that shown in FIG. 4. In such reoriented lateral position, the keyboard 16 would be disposed on the right hand end as viewed by the person holding the data terminal.

If a person would be holding the data terminal 10 by the right hand in the upright position shown in FIG. 2, the natural twisting motion permitted by the wrist would similarly transpose the data terminal 10 from such first upright position to a second lateral position in which the keyboard 16 would be disposed at the left end of the data terminal. Such latter reoriented position would ideally require a reorientation of the indicia into the arrangement shown in FIG. 3. Thus, a left handed person may require a different lateral orientation of the keyboard indicia and functions than a right handed person. In contrast, the upright position is accessible equally to both left and right handed persons.

Further in reference to FIG. 6, the lower end 140 of the data terminal may typically be a battery compartment containing a power source 145 for electrically driving the functions of the data terminal 10. A bank 146 of external contact elements 147 may be disposed at the lower end 140 to provide an external power input terminal, such as for recharging the battery. The external contact elements 147 also serve for hard wired direct data transfer. Such direct data transfer mode via the contact elements 147 would be required when the data terminal 10 is intended to be operated in a batch type data communications mode, in which data collected over a period of operation of the data terminal 10 would be retained in storage memory 148 (see FIG. 7) to be subsequently transferred in a single transfer operation to a host computer.

In reference to FIG. 7, the operation of the data terminal 10 is controlled by the operation of a microprocessor 151. The operation of the microprocessor 151 is typically controlled by a control program or operational program containing instructions. In that such a program defines the operating characteristics for the data terminal 10, the operational instructions thereof are stored in an essentially permanently encoded memory portion 152 or read only memory ("ROM"). The operational program stored in the ROM 152 in combination with the microprocessor 151 is contemplated to operate in the preferred embodiment the various operational modes of the data terminal 10. For example, the above-referred to selective activation of the touch sensitive active area 32 is readily controlled by defining which of the touch sensitive values defining positions are to be accepted. A similar procedure may be used in recognizing a hand written

character in accordance with a manual written input procedure by which characters may be recognized and displayed on the display screen 15 for acceptance or correction by the operator of the data terminal 10. The operational program also controls the orientation in which the data are displayed on the display screen 15. As a correlative, the program assigns in accordance therewith the functions of the keys 46 and of the active key areas 36 of the touch sensitive keyboard array 34. The indicia 37 are then accordingly displayed on the display screen 15, marking each of the key areas 36 with its respective function. Further, as described herein, reorientation of the display and the respective keyboards are similarly performed in accordance with instructions received by the microprocessor from the ROM 152. Typical instruction routines relating to addressing the display screen are known in the art, though particular address routines may be specified by manufacturer's of specific microprocessor circuits.

Collected data and temporary addresses may be stored in the random access memory 148 ("RAM"). The RAM 148 is ideally of substantial capacity, in that the memory 148 stores collected data and functions as the working memory of the microprocessor 151, storing addresses for the display screen 15, for example. These latter addresses include addresses for the indicia 37 of the keyboard array 34 and addresses used for reorientation functions. A data bus 154 is typically coupled to a communications interface circuit 155 ("COM") and to the external contact elements 147 or equivalent output devices. If the data terminal 10 is expected to be operated in an interactive mode, the microprocessor 151 may

communicate through the communications interface circuit 155 with a radio module 156. Another desired function of the data terminal 10 is a READER 157, such as an optical bar code scanner. The above referred-to sensors 70 and 71 which form part of a keyboard orientation function shown as KEYBOARD ORIENTATION 158 would be sampled by the microprocessor 151 in accordance with the operational program stored in the ROM 152. The operational program would further contain routines for reorienting the display screen 15 and the assigned functions of the individual keys 46 of the keyboard 16 (see FIG. 1). Reorientation may proceed according to the sensed orientation of the template 43 as described above in reference to FIGS. 2 through 5, or in accordance with other desirable routines embedded in the operational program. For example, reorientation may be implemented solely based on a combination of keystrokes on either the keyboard 16 or the touch sensitive keyboard array 34. FIG. 7 further shows schematically the self contained power source 145 ("BATTERY AND POWER MANAGEMENT") having typical "+V" and ground terminals for driving the described electronic functions. Because of the expected portable use of the data terminal 10, power management is deemed to be necessary for extending the operating cycle of the data terminal 10 between required recharging operations. The power source 145 may include "power management functions" including power switching functions which temporarily remove power from selected working elements during periods of non-use. The removal or shutdown of functions during non-use desirably occurs automatically. In a preferred mode, power may be supplied to desired section in response to an operator initiated input on the keyboard. When in the shutdown mode, the first

keystroke by an operator will not be registered as a keyboard input of the function executed normally by the depression of the respective key, but as a command to resume operation, hence, to power up the respective functions of the data terminal 10.

FIG. 8 shows a modification of the data terminal 10 as shown in FIG. 1, in that an optional reader module 160 is shown attached to the upper end 139. The reader may be a laser scanner bar code reader having an optical window 161 through which a laser beam scans across a bar code and through which a selectively reflective signal is received by the reader 160.

FIG. 9 shows an alternate embodiment in which an end handle 165 is attached to the lower end 140 of the data terminal 10. The use of a handle 165 allows the data terminal to be held or carried other than by grasping the hand grip portion 133 in the rear housing shell 131. The end handle 165 may be added at either or both the upper and lower ends 139 and 140, provided other options, such as the reader 160 shown in FIG. 8 is not desired. An advantage of the end handle 165 is that an additional power source may be embedded therein and be part of the handle, the attachment of the handle 165 to the lower end 140 making connection to the external contact elements 146, thereby coupling the added power source of the handle 165 to the existing power source 145. The handle 165 may similarly to the data terminal 10 feature in a lower end 168 contact elements 169. The contact elements 169 may be coupled through the handle 165 to respective ones of the contact elements 147, thereby maintaining the function of the contact elements 147 while the end handle 165 remains attached to the lower end 140 of the data terminal 10.

FIG. 12 shows a pen-based data terminal system designated generally by the numeral 175. The data terminal system 175 includes a data terminal designated generally by the numeral 176 and further includes a data pen 177. As described with respect to FIGS. 12 through 19, the data terminal 176 may include an underlying digitizing array, or as described with respect to FIGS. 25 and 27, the data terminal 176 may feature a touch sensitive overlay area 32, as described above. Each of the two referred to data input devices are allow graphic or cryptic data inputs. They are similar in many respects, as will be apparent, but they also have their distinctions, each having possible advantages and disadvantages as will be pointed out. The described touch sensitive overlay 32 is, of course, exposed, and subject to accidental data entry. On the other hand, there may be price advantages and also advantages of convenience when using a touch sensitive overlay 32 or touchpad 32. For example, the touchpad 32 does not have to rely on a special pen 177, as described, but may make use of any available pointed instrument, or even an operator's finger to obtain an input signal, as described above.

In reference to FIG. 12, the data pen 177 is an operator manipulated data input device which functions as a means for enabling an operator to input data into the data terminal 176. The data pen 177 is shown somewhat schematically to best illustrate its elements in reference to the function of the data pen 177 with respect to the data terminal 176. The data pen 177 is an electromagnetic, active "pen" or stylus which interacts with an array of planar coils 178 disposed as an underlay array 179 beneath an LCD screen 180 of the data terminal 176. An advantage of the underlay array 179 in comparison to the

previously described touch sensitive active surface area 32 of the data terminal 10 is the fact that it is an underlay beneath, as opposed to an overlay on, the LCD screen 180. The LCD screen 180 may have as an outer surface layer 181 a tempered glass sheet 181. The strength of the glass sheet 181 or any equivalent similar transparent protective material would be likely to shield the screen 180 from accidental damage, furthering an object to provide an optimally robust data terminal 176. By accepting data inputs from the data pen 177 through the screen 180 only, the outer surface sheet 181 protects the underlay array 179 in addition to the LCD screen 180 as such.

In further reference to FIGS. 12 and 13, external features other than the positioning of the underlay array 179 beneath the screen 180 add to the robustness of the data terminal 176. The robustness or resistance to damage of the data terminal 176 is further sought to be enhanced by providing outer shock absorbing features. At an upper end 184 of the data terminal 176 an outer cushion 185 of a "co-molded" resilient material, a cured thermoplastic rubber material, covers in a slight bulging or outward protruding manner substantially the entire surface of a comparatively hard molded plastic base shell 186 at the upper end 184. The base shell 186 constitutes an inner "back bone" of a housing 188 which defines the overall shape of the data terminal 176. The outward protruding resilient material features with respect to otherwise generally rectangular lines of the housing 188 would most likely be first to contact a fall breaking hard surface in a fall of the data terminal 176.

A frontal side or face of the housing 188 supports the LCD screen 180 and a keyboard 191. The screen 180 is shown to be of rectangular shape, having a height in a longitudinal direction of an axis 192 of the housing 188 which is greater than a width in a direction transverse to the axis 192. The LCD screen 180 may be structured in any of a number of known manners of assembling such screens. The LCD screen 180 may be assembled pursuant to a special procedure which aligns the coils 178 of the underlay array 179 in a predetermined manner with respect to the LCD screen 180.

In further reference to FIG. 14, a LCD screen assembly process which is considered advantageous to properly align the display screen 180 in relation to the underlay array 179 includes an initial step of temporarily mounting the LCD screen 180 to a bottom bumper of a main circuit board or main logic board, using a low-tack adhesive ("TEMPORARY MOUNT LCD TO MAIN BOARD"). Main logic, rows and columns of the coils 178 in the underlay array 179 now become registered on standard physical tooling holes used in the fabrication of the main circuit board, and on corresponding pins projecting from an assembly fixture ("LOCATE COILS ON ASSEMBLY FIXTURE"). Thereafter, the temporary mounting of the LC screen 180 to the main circuit board is removed. Light is used to optically align the coils 178 and a corresponding active area of the LCD screen 180 with respect to such assembly fixture ("OPTICALLY ALIGN ACTIVE AREA"). After an alignment has been accomplished, an assembly operator will lower the LCD screen 180 onto an adhesive base associated with for example such main circuit board ("LCD FINAL BOND"). The assembly process may be used to align various edge contacts of the LCD screen 180,

as are well known in the art to exist, with respective circuit connections as may be provided on a main logic board or main circuit board 193 (see FIG. 18).

In particular reference to FIG. 12, the keyboard 191 may be an advantageously assembled structure having plastic, sculptured keys 194 which preferably include numeric and select function keys. The keyboard 191 further shows a sculptured, orthogonal cursor movement key cluster 195. The keys 194 and 195 extend through respective openings 196 of what is referred to as respective "crates" on an underside of a keyboard upper keypad 197. A die-cut foam perimeter gasket at 198 provides a water seal along the periphery of the keypad 197 to the housing 188. The housing 188 is formed at a preferred slight angle outwardly rising away from a main plane of the LCD screen 180 and the general extent of the data terminal 176. An angle which lies in a range of about ten degrees with respect to the plane of the LCD screen 180 provides an advantage of protecting the keys 194 and 195 from contact with a flat surface should the data terminal 176 come to rest on its face. Secondly, the tilted keyboard 191 provides a mounting space at a lower end 199 of the housing 188 with respect to a main logic board 200, as schematically shown, for example, in FIG. 18. A flexible circuit connector strip 201 (also shown schematically in FIG. 18) provides for a substantially stepless transition between the plane of the LCD screen 180 and that of the keyboard 191 (see FIG. 12).

Again in reference to FIG. 12, a protective cover door 205 is shown as a representative door 205 which may be used to protect electrical connectors, such as connector 206, or other data interfaces, as recessed at 207, when no connection

is made to the outside in the absence of peripheral devices or other communicatively coupled external equipment. The cover door 205 desirably features a co-molded peripheral sealing strip or seal 208. A co-molded seal is believed to have an advantage over typical O-ring type seals, for example, in that a co-molding process provides a positive and continuous seal between the cover door 205 and the seal 208. It is therefore desired to extend a co-molding process from providing shock protection to generating such positive seals on plastic molded parts, such as the cover door 205, which are to join other structural parts. It is to be realized that the base shell 186 would advantageously be molded in convenient half shells to be assembled in accordance with the teachings herewith. Co-molded surfaces may also be provided generally along opposite side surfaces 210 and 211 of the data terminal 176. A convenient LCD screen 180 may be one of 480 x 320 pixel (One half VGA) as may be obtained commercially from Epson, for example. A commercially available size for such an LCD screen 180 renders the data terminal 176 with lateral external dimensions which exceed typical grip dimensions. A co-molded rubber exterior on the opposite side surfaces 210 and 211 of the data terminal 176 not only increases the aesthetic value of the data terminal but also enhances the grip that an operator of the data terminal 176 may have during its operation.

Co-molded rubber is found to be particularly advantageous for the shock absorbing elements, such as the outer cushion 185, as well as for sealing strips besides typical skin overmolds on hand grips or the like. The term "co-molding", as used herein, refers to a known manufacturing process wherein a part, such as the base shell

186, is first molded, for example, in an injection molding process. FIG. 15 depicts a simplified cross-sectional view of a first mold 216. An upper mold part 217 is closed against a lower mold part 218, and a thermoplastic molding material is injected. The injected material cools and hardens to form, for example, a cap 219 in complementary upper and lower molding cavities 220 and 221 of the respective upper and lower molds 217 and 218. The molded part 219 is thereafter inserted into an second mold 223 which has molding cavities 224 and 225 in upper and lower mold shells 226 and 227, respectively. The cavities 224 and 225 are larger and of altered shape when compared to the first cavities 220 and 221. The molding cavities 224 and 225 not only receive the already molded part 219, but also allow space for the injection of a second molding material, as, for example, the thermoplastic rubber material 228. The molded part 219 is disposed within the second mold 223 to form with its outer surface 229 one boundary surface of the space into which the thermoplastic rubber 228 will be injected. Heat energy from the injected hot rubber material 228 tends to plasticize the outer surface 229 of the already molded part 219 to form a somewhat homogeneously linked boundary region along the surface 219 of the molded part. The boundary region conforming with the surface 219 has been found to yield a strong bond between the two molded materials or parts 219 and 228. The bond is essentially leak proof. The co-molding process appears therefore ideal for forming sealing strips for the data terminal 176, such as the seal 208. The bond appears also not to be confined to a planar surface along the original surface 229. Instead the boundary surface 229 appears converted into a boundary region 229 having a depth along the

original surface 229. The region 229 tends to permit a greater dispersion of shear forces. As a result, impact forces tend to become more evenly distributed and dispersed across the surface of the underlying parts 219 or 186 in comparison with a typical surface-adhered shock absorbing material.

Again in reference to FIGS. 12 and 13, the housing 188 includes at its lower end a "pen clip" 231 which is a channel 231 of substantially cylindrical cross section which extends transversely to the axis 192 across the lower end 199 of the housing 188. The channel 231 is advantageously formed of flexible material such as the thermoplastic material used for shock absorbers and for seals as described herein. The pen clip channel 231 may therefore be co-molded in a process similar to the process described with respect to FIGS. 15 and 16. The channel 231 is advantageously formed with open ends 233 at both ends and the cross section of the channel 231 may be substantially uniform. The pen clip channel 231 is rendered thereby "bidextrous" or user friendly to both left handed and right handed operators. The pen 177 is inserted into the channel 231 or removed therefrom with essentially the same motion by either hand.

FIG. 12 further shows at a lower end of the data terminal 176 a plurality of spaced and aligned communications coupling elements 235. The elements may be molded through an adjacent portion of the base shell 186, allowing communication through the base shell without relinquishing a hermetic seal afforded by the base shell 186. The couplers may be electrically conductive couplers, also referred to a surface contacts, particularly those coupling elements 235 which are to provide alternate electric power to the data terminal 176

when the unit is inserted into a docking cradle 236 as schematically shown by phantom lines in FIG. 13. Various types of communications couplers may be used including optical coupling elements which may be molded through the base shell 186 in a similar, hermetically sealed manner as metallic, electrically conductive contacts. Even electromagnetic transducers may be considered feasible as hermetically sealed communication coupling elements. The data terminal 176 may become seated within the docking cradle 236 to communicate via complementary communication couplers 237 within the docking cradle 236 with an external data device 238 ("HOST") of any of a number of types including a host computer of a data system 238, as schematically shown in FIG. 13.

Any cable connectors which are accessible externally of the housing 188, as shown by a representative coaxial connector 239 in FIG. 12 are also preferably hermetically sealed into the base shell 186, such as by co-molded gaskets 241. A closure 242 depicts a battery compartment access door 242. The data terminal 176, being portable and self-contained, includes a battery which is part of an internal power function 243 (see FIG. 18). The power function 243 is schematically shown and represents generically a combination of separate power sources, preferably three separate power sources. These power sources are either replaceable long life batteries or, in case of a main power source, preferably a rechargeable battery. The batteries are coupled to respective circuit elements to provide separate main and back-up power. Operating circuits and peripheral devices of the data terminal 176 would desirably be powered for the duration of a working day. Pseudo-static memory devices on the other hand

would desirably remain under power continuously, particularly in the absence of the main battery of the power function 243. If a user undertakes were to remove a battery through the door 242 for replacement or otherwise without first shutting down the operation of the data terminal 176, addresses or data written to operational registers might be rendered vulnerable. Even if the data terminal 176 were re-energized and a routine were to be executed to return the data terminal 176 to the latest operation prior to the power failure, with any register content having been destroyed, a continuation of work at the point of sudden power interruption may no longer be possible.

In accordance with a particular feature of the data terminal 176, a user friendly environment is intended to exist, within which an accidental loss of data is minimized, if not virtually eliminated. Multiple power sources are known to have been used in the past to assure continuity of data retention during battery replacement. Thus, when a "low battery" indication is given, a first battery may be replaced, while a second battery maintains power on the particular unit. Such prior redundancy of power sources to retain emergency power on the data terminal 176 was found to be insufficient to assure continuity of service without loss of data. The data terminal 176 is expected to operate continuously through any selected application or operation in spite of frequent, planned power interruptions within the period of continuous operation. Functionally, the data terminal 176 is expected to store all active states at the end of any operation in pseudo-static or static memory, hence, non-vulnerable memory, and to save all processor and input-output register states prior to any sudden shut-down or power interruption.

In reference to FIG. 17, the battery compartment door 242 includes therefore a shutdown alarm activation element 246 which causes the data terminal 176 to receive an advance signal that the battery compartment door 242 is about to be opened and that the main battery power may be lost before such loss occurs. Upon receipt of such warning signal, the data terminal 176 may enter a shutdown mode and be in a shutdown condition when the power is ultimately lost. The shutdown condition is synonymous with having all signal states saved to resume operation from the shutdown condition when power is restored to the data terminal 176. In particular, the battery compartment door 242 is shown as a quarter-turn quick release door 242. A substantially circular shape of the battery compartment door 242 includes peripherally opposite camming members 247 and 248 which may be symmetrical. The camming members 247 and 248 engage and would be received by complementary cutouts or recesses 249 in the housing 188 (see FIG. 12). FIG. 17 may be visualized as showing the camming members 247 and 248 in a locked position with respect to the housing. A quarter turn of the battery compartment door 242 in the direction of arrow 250 would align the camming members with the respective cutouts 249, thereby permitting the opening of the battery door. The battery compartment door 242 further comprises at least one camming recess 246 which constitutes the alarm activation element 246. It may be preferred for symmetry to include a second, opposite camming recess 251 into the battery compartment door 242. When the battery compartment door 242 is locked, the recess 246 or its symmetric equivalent recess 251 would be sensed by an electric signal device, such as a switch 252. The switch may have a plunger 253 which extends into the peripheral

recess 246 to place the switch into one of two logical signal positions, closed or open. When an attempt is made to open the battery compartment door 242 and before the door 242 may be removed, a camming action of the recess changes the state of the switch 252 to permit the switch to thereby warn of an impending loss of power from a main battery pack 255 disposed behind the battery compartment door 242. It should be understood that the described camming action by the peripheral recesses 251 or 246 against the corresponding mechanical switch are but one embodiment for generating a signal warning of an impending opening of the battery compartment door 242. Optical, magnetic, inductive or other sensing means are known to detect a movement of a mechanical element with respect to another. The use of the described sensing provision for sensing the removal of the door to request a shutdown mode of the data terminal 176 is of significance, though. As will be understood from the description herein, placing the data terminal into an immediate shutdown mode when no operating condition is required has further been found to result in significant power savings, permitting the operating cycle of the data terminal 176 between recharging operations to be extended.

Power management with respect to the data terminal 176 is of significance. Power management provides customer satisfaction by extending operating periods between battery charging operations. Co-pending patent application Serial No. 07/898,908, filed June 1992 by Koenck et al. and assigned to the owner of this application, discloses related developments which may be advantageously applied to the data terminal 176 as described herein. The referred to co-pending patent application discloses a modular data

terminal and further an interactive use of an application and a control microprocessor. The control microprocessor monitors essential functions on an ongoing basis while a power intensive operation, as executed by the application microprocessor, for example, is terminated and the respective device is powered down immediately upon conclusion of such operation.

It is found in accordance herewith that significant further power savings can be achieved when operations of the data terminal 176 in their entirety may be shut down effectively during even brief inactive periods. Though data terminals may be shut down and then resume operation is possible, the time required to resume at the point of disruption of operation must desirably be brief to be practical. Static or pseudo-static memory circuits are well known through which data may be retained when power is shut off to a data unit similar to the data terminal 176. However, it has been found that units which provide for permanent of semi-permanent retention of data or information do not provide the protection of the operations for use in randomly interruptable and resumable operations. It is understood that state of the art apparatus, for example, a portable computer may be shut off while in an application program, such as a spread sheet, for example. On a subsequent power up, the computer will return to the application program from which it exited when turned off. Such resumption will be possible when information which is currently displayed on a screen is stored in pseudo-static RAM or static RAM devices of the computer.

The data terminal 176 includes a power saving feature which permits the data terminal 176 to be placed into a "sleep mode" during periods of

inactivity and to resume operation from a status at the beginning of such sleep mode. FIG. 18 is a schematic representation of the data terminal 176 to which reference is made in the description of the power saving function. The data terminal 176 preferably makes use of power saving features described in the referred to application Serial No. 07/898,908, filed June 1992. A preferred microprocessor device is an AMD 386 microprocessor 261 (MP 386). An address bus 262 and a data bus 263 couple the microprocessor 261 through a buffer 264 (BF) to a flash memory device 266 (FLASH MEM) and to a computer device 267 referred to as a "SCAMP" (SCAMP 82C315). The data bus 263 further couples the microprocessor 261 to a pseudo-static RAM memory device 268 (PSRAM). The memory 268 is preferably a low power memory device which is backed by a long-life backup battery as is common in the art, the backup battery not being shown separately from the memory device 268. The memory address bus 262 is further coupled through the SCAMP device 267 by an extension bus 269 via a further buffer device 271 (BF) to the memory device 268. The memory address extension bus 269 is further coupled through the buffer device 271 to a memory extension connector 273 (MEX CN). The data bus 263 is also coupled to the memory extension connector 273.

The memory extension connector 273 may according to the embodiment of FIG. 18 be a standard connector for what is known as a memory card 274 pursuant to PCMCIA standards. Memory cards are typically removable and may be furnished either with extension RAM memory or may contain peripheral or I/O devices, such as disc storage devices, modems or the like. Pursuant to a related development disclosed in a co-pending patent application Serial No. 07/982,303, filed on

November 25, 1992 by Steven Koenck et al. and assigned to the assignee of this invention, a mechanical switch 276 may be mounted adjacent the connector 273 and may be coupled to sense the presence of a special memory card (not shown) which may alter priority access of available memory by prioritizing a startup sequence from the special memory card instead of from memory locations internally available to the data terminal 176.

The SCAMP device 267 is coupled by shared data and address buses 281 and 282, respectively, to an I/O connector board coupled through a typical connector, the combination of which being identified schematically by an I/O connection 283. The I/O connection 283 is further coupled to the SCAMP device 267 by a local address bus 284 and by an interrupt request bus 285. A communication interface circuit 287 (COMM INTERF) is coupled to the shared data and address buses 281 and 282 and is further coupled to a control or management microprocessor which manages power saving features as set forth in the above co-pending application which identifies a presently preferred microprocessor device as a Hitachi H8 type processor. Static RAM 289 is coupled to respective address and data buses 291 and 292 of the control processor 288. The communication interface device 287 communicates with a digitizer logic board 294 of the array 179 (see FIG. 12) and with the keyboard 191. As can be seen from in reference to FIG. 19, the communication of the interface device 287 with the logic board 294 of the array 179 is in parallel with the communication between the interface device 287 and the keyboard 191. This provides the advantage that with separate interrupts, the keyboard 191 and the array 179 are independently operable of

each other. In the event the array 179 fails to operate, an operator of the data terminal 176 is capable of proceeding with entries via the keyboard 191. In the event of a lockup of the keyboard, data or commands may be entered via the array 179. Even while both devices 179 and 191 are functional, data may be entered via both devices interchangeably or even simultaneously. In this respect it should be realized that data generation by either the movement of a pen device over the surface of the digitizing array 179 or consecutive key manipulations by an operator is by far slower than the operating speed of, for example, the microprocessor 261, or even the operating speed of the control microprocessor 288. This distinction of being interchangeably operable with keyboard and pen data inputs is seen as a distinct advantage over other handheld data terminals which operate as keyboard entry devices. Other prior art terminals with touch sensitive screens or with digitizing arrays use this type of cryptic data entry more as a novelty, but then do not provide the utility of allowing an operator to switch operation, at will, between data entry via a touch screen or the array 179, and the keyboard 191. The dual operation has been found to be a user-friendly improvement over prior art terminals lacking such option.

The control microprocessor 288 further operates a power control function through a power control device 295. The shared data and control buses 281 and 282 are further coupled to a VGA controller 296 which interfaces with special video DRAM 297 and the LCD screen 180.

A special interrupt function of the SCAMP device 267 is used to trap all outgoing instructions to the I/O connection 283 and to shadow write such instructions to the SRAM device

289 or other designated static memory. Thus, at any time during the operation of the data terminal, not only are all data retained in static memory to be retained during power loss, but the control addresses of all input-output devices are likewise preserved. All normal power interruption causes are contemplated to be provided with advance warning signals to allow the communication interface circuit 287 and the SCAMP 267 to store the status of all of the registers of the 386 microprocessor circuit 261 in permanent memory during a permissible shutdown period provided by such advance warning signal. The advance warning signal may therefore be provided when an accessory pod or panel 300 (see FIG. 13) is opened which may disconnect an input-output device from the connection 283. A similar signal may be provided when the data terminal is powered up and the power switch is operated. Thus, before the data terminal is powered down, the status of the data terminal 176 is stored in memory.

Further in accordance herewith, the shadowing of data in permanent memory and of all I/O instructions as described herein, allows the control processor 288 to shut down the terminal entirely during even brief periods of inactivity. The communications interface circuit 287 may include such special timing instruction which minimize a delay before such a shutdown of the data terminal 176 occurs. The timing delay may be adjustably controlled by an operator or it may be automatically set based on usage intervals and re-activations of the data terminal 176. Such a shutdown can then immediately be restored by a "RESUME" function key which may be one of the keys 194 shown in FIG. 12.

Further in reference to FIGS. 12 and 13, the accessory panel or accessory pod 300 in FIG. 13 is

a pod-like shape in the form of a relatively narrow handgrip configuration 310 in comparison to the overall width of the data terminal 176. The handgrip configuration or handgrip 310 is configured to a grasp width of an average user of the data terminal 176, while the width of the data terminal 176 might otherwise be held by its sides, but not readily from beneath. The pod 300 serves a dual function, a first in being a housing for accessory functions of the data terminal 176, a second in providing the handgrip 310 for a user. A handstrap 311 may be used to further securely retain the data terminal 176 in contact with a user when the grasp of the user relaxes on the pod 300. To understand the significance of the handgrip 310, the narrow handgrip 310 is contained beneath the data terminal 176 and within the panel area of the accessory pod or panel 300. A user of the data terminal 176 can readily hold on to the data terminal 176 by grasping the handgrip 310, with the hand of the user holding the data terminal 176 being entirely positioned away from the screen 180. The data terminal may be reconfigured in accordance herewith with selected functions which are housed within the housing 188 and which are accessible through the accessory panel 300, or through a selected one of a plurality of different accessory panels 300. The accessory panel 300 is shown as a representative one of the panels. The handgrip portion may house a scanner unit operating through a window 312, for example. Alternatively the handgrip portion may house such other devices as added memory, a transceiver module, additional battery power, communication devices, such as modems, or other desirable functions in a data terminal 176. The handstrap 311 is attached to the handgrip portion 310 and a second handstrap 314 is disposed at the

end 184 of the data terminal 176. The second handstrap 314 is preferably non-resilient and may be adjustable in length by being split and having a hook and loop fastener on overlapping edges.

FIG. 12 shows certain details of the pen 177 which interacts through the array of coils 179 and the digitizing circuit 294 to permit data input. A particular advantage of the electromagnetic feature of the pen 177 is that inadvertent activation of a data input by hand pressure on the display screen 180 is virtually eliminated. The pen 177 includes in one embodiment a known electromagnetic activation circuit 315 and a battery 316. A grip-sensitive switch 317 may be used to activate the electromagnetic activation circuit 315 only when the pen is actually held in a user's hand. In one embodiment, the grip sensitive switch may respond to heat as well as to pressure to energize the circuit 315 of the pen 177. Thus, when the pen 177 is inserted into the channel 231, any pressure due to the insertion of the pen 177 will not activate the electromagnetic circuit 315.

FIG. 19 shows a main circuit board 325 which is modified with respect to the main circuit board 193 described with respect to FIG. 18. One change with respect to the previously described main circuit board 193 is that the pseudo-static RAM device 268 has been replaced with a typical dynamic RAM memory device 327. Another notable change is that a memory extension device 328 is not positioned externally of the main circuit board 325 to the board, but is removably mounted to the main circuit board 325 itself through a typical sub-circuit connector socket which is not separately shown, but which preferably is a typical device socket which may be commercially obtained to couple a subcircuit such as a memory

extension board 328 ("EXT MEM") to the main circuit board 325. FIG. 19 further shows a memory refresh circuit 329 ("REFRSH").

The switch 276 may be used in its previously described function in conjunction with one or both of two PCMCIA connectors designated generally by the numeral 330 and 331. These connectors 330 and 331 may be part of a special input-output function interface board 332 (see FIG. 20). The switch 276 would be positioned to detect the presence of a special function card in one of respective receiving slots 333 and 334 of the connectors 330 and 331. A coupling of the switch 276 to the connector 330 and the respective card receiving slot 333 is shown in FIG. 19.

FIG. 20 depicts functional elements which are, according to a preferred embodiment, mounted on the special input-output function interface board 332 ("I/O BD"), further referred to as I/O board 332. An advantage of the use of the I/O board 332 as an addendum to, but as a separate structural element from, the main circuit board 325, for example, is an increased ease of assembly and a promotion of modular concepts. A use of modular concepts permits the data terminal 176 to be adapted to special uses. In reference to FIGS. 19 and 20 and the preferred functional layout of a combination of the main circuit board 325 and the I/O board 332 shows that substantially all internal operational functions of the data terminal 176, those which are expected to remain the same for most, if not all, applications, are supported by the main circuit board 325. On the other hand, input-output functions may vary among different special use applications of the data terminal 176. The less permanently defined input-output functions are therefore found on the I/O board 332. The data terminal 176 may

therefore undergo a basic functional modification by the removal of the I/O board 332 for a different I/O board with different input-output functions. Components on the main circuit board 325 need therefore not be changed. However, with changed input-output functions and parameters, a control program which would be resident in the flash memory 266 may need to be updated to account for changes in operating default settings of now different input-output functions as provided by a different I/O board.

Physically and communicatively, the I/O board 332 is coupled through the I/O connection 283 to the main circuit board 325. The connection 283 may be established between mating I/O connectors 336 and 337 mounted, respectively, to the main circuit board 325 and the I/O board 332. The respective I/O connectors 336 and 337 couple and extend the data and control buses 281 and 282, the local address bus 284 and the interrupt request bus 285 to the I/O board 325. The data and control buses 281, 282, the local address bus 284 and the interrupt request bus are depicted in FIG. 20 as an I/O signal and control bus 340.

A basic version of the I/O board 332 is preferred to include input-output functions as shown in FIG. 20. An Ethernet controller 345 is a commercially available Ethernet controller device. The Ethernet controller is communicatively coupled through the I/O signal and control bus 340 to the data terminal 176. Communication between external devices and the data terminal 176 is obtained through a 28-pin data connector 347 and a bank of coupling elements, such as surface contacts 235 of the data terminal 176. Signal pairs 348 and 349 from the Ethernet controller 345 are preferably coupled through an isolation transformer device 350 to

external communications couplers, such as to the data connector 347 or to the surface contacts 235. It has been determined that parallel connections to both the typical 28-pin type communications connector 347 and surface contacts, such as the surface contacts 235 (see, for example, FIG. 12) increases the usefulness of the data terminal 176. Consequently, communications leads 351 and 352 on an external side of the isolation transformer 350 are coupled to respective terminal contacts of both the 28-pin connector and of the bank of surface contacts 235.

A second desirable communications controller on the I/O board 332 is a Dual UART device 355. The Dual UART (Universal Asynchronous Receive and Transmit) device 355 is coupled internally of the data terminal 176 to the I/O signal and control bus 340 and for external communications to respective RS 232 and RS 485 control circuit devices 356 and 357, respectively. In furtherance of advantages obtained through a dual coupling function via both the connector 347 and surface contacts 235, standard connections of the RS 232 and RS 485 devices are also contemplated to be coupled to designated control and data terminations on the 28-pin connector 347 and respective ones of the surface contacts 235. The portable data terminal 176 may typically not be regarded as the type of device the usefulness of which may be enhanced by linking provisions to communication networks such as Ethernet. However, it has been discovered that a full function of the data terminal 176 is implemented only when an efficient operation of collecting data at the working level of a complex data system is supplemented by equally efficient communications with the data system. In furtherance of this, Ethernet capability is found to provide a

communications link of significance. Ethernet may be used, to give but one example, for data exchange with a data system external to the data terminal 176, during docking periods, for example, when batteries are being recharged. FIG. 13 shows the data terminal 176 coupled through a docking cradle 236 to an external data device 238 which may be considered to be a data system 238 within which the data terminal 176 is functional. External power may temporarily be applied to the data terminal 176 while the data terminal is located in the docking cradle 236. Such external power may be used to conserve power consumption from the power pack 243 and to recharge the power pack as needed.

A battery charging control circuit 359 is desirably located on the I/O board 332 in that battery charging connections are made through selected terminations of the surface contacts 235. Other external connections, such as any convenient power plug, may of course be provided in addition to designated ones of the surface contacts 235 as shown in FIG. 20. Smart battery charging control circuits are known and are desirably used within the data terminal 176 itself to provide protection to the data terminal 176 from damage due to improper charging procedures or failure of controls that may otherwise be available in standard battery recharging apparatus (not shown). The control circuit 359 has the function of limiting the magnitude of a charging current that may be admitted to batteries of a power pack 243, for example.

The I/O board 332 is also found to desirably contain a communications control interface device 360 to one or more PCMCIA card slots, preferably the two card connectors 330 and 331, as described above with respect to FIG. 19. Though PCMCIA

cards may serve to provide added storage capacity to apparatus, such as a data terminal, known diverse uses for PCMCIA cards most properly allow these cards to be considered data input and output devices, rather than primarily data storage devices. In reference to FIGS. 19 and 20, the special switch 276 is desirably associated with detecting a special use card in the respective card slot 333 associated with the connector 330, such that the flash memory 266 on the main circuit board 325 may be updated whenever the presence of a special memory card is detected by the switch 276.

The I/O board 332 further features a pod connector 365, through which connection is made to the respective accessory panel or pod 300 and to any respective data collection or communications device located therewith. The pod connector 365 is communicatively coupled to the I/O signal and control bus 340, just as the Dual UART device 355 and the Ethernet controller 345. The accessory panel 300 may, for example, contain a bar code scanner, as indicated by the window 312 in FIG. 13. The accessory panel 300 may instead house data communications apparatus, such as an RF transceiver, or a modem. The accessory may be controlled internally by a microprocessor circuit of its own for processing data in accordance with the function of the respective accessory device, the processed data then being transferred to the data terminal 176 via the I/O signal and control bus 340. However, data flow between the data terminal 176 and the accessory pod is preferably controlled by the data terminal 176 by control signals from the main circuit board 325 applied via the I/O signal and control bus 340.

In further reference to both FIGS. 19 and 20, the flash memory device 266 is shown coupled to

the shared data and address buses 281 and 282 as a modification with respect to the embodiment shown in FIG. 18. The I/O connection 283 is also coupled to the shared data and address buses 281 and 282. The PCMCIA card connectors 330 and 331 may therefore be coupled through the I/O board 332 to communicate via the shared data and address buses 281 and 282. FIG. 19 further shows an circuit block 370 ("LCD CON - EL CONTROL") which represents an LCD contrast control function and an electroluminescent panel ("EL panel") backlighting control for the LCD screen 180. The coil array 179 is also shown schematically in dashed lines as underlying the LCD screen 180. The digitizer control circuit 294 is coupled to the coil array 179 to scan the coil array for activated coils and pass the digitized data to the communication interface circuit 287.

It is intended for both the communication interface circuit 287 and the SCAMP device 267 to share the task of writing active states and data to shadow memory, thereby enabling an full power down without loss of states and data in accordance herewith. FIG. 19 shows the central location of the SCAMP device 267 and the communications interface device 287. A bus signal or control bus 372 is shown coupled from the microprocessor 261 to the SCAMP device 267. It may be realized that power savings procedures are deemed to have high priority in the functional arrangement of FIGS. 19 and 20. An audio circuit device 273 ("AUDIO") is shown coupled directly to the maintenance microprocessor 288 and the communications interface device 287.

Memory devices 327 and 328 are shown to be coupled directly to the data bus 263 of the applications microprocessor device 261. Row and column address buses 376 and 377 of the main

application memory devices 327 and 328 are addressed through the SCAMP device 267. Initial operating instructions for the main or applications microprocessor 261 reside in a read only memory 378 ("ROM"). An address control bus to the ROM 378 is coupled to the shared address bus 282 rather than directly to the address bus 262 of the microprocessor 261. In accordance with an advantageous arrangement of the data terminal 176, reset and initial start up instructions, as well as system control code may reside in the flash memory 266. However, in that some of the commercial devices are reset in one or another state during initial start up, it remains desirable to obtain an initial instruction for the applications microprocessor from a masked ROM device, such as the ROM 378. The maintenance microprocessor 288, in functioning as a relatively slow operating control microprocessor, obtains its reset and start up code through a respective maintenance data bus 381 as addressed by a respective maintenance address bus 382 which are coupled to the static ram device 289. The maintenance microprocessor device 288, retains its operating code independently of battery voltage levels. In case of memory failure, the maintenance memory 289 may be renewed or rewritten by the applications microprocessor 261 pursuant to programs stored in the flash memory 283, or as further updated via the PCMCIA special functions available through the connector 330 and a special updating card. The maintenance microprocessor 288 further shows an interrupt request bus 385 which is used in the power maintenance function to communicate possible alarm or interrupt conditions between the microprocessor 288 and the communications interface circuit 287.

FIG. 21 is a flow chart of an interaction between both a control program as it may reside in memory of the data terminal 176, and certain circuit states of the circuit functions of the circuit board 325, for example. The operation of the data terminal 176 is comprised of separate functions of executing application programs or "performing application tasks", such as collecting, processing or communicating data messages, and a continuous power management procedure. Pursuant to the unique power management procedure which is enabled by the described circuit function, power to the data terminal 176 may be shut down any time the data terminal is not in use, or during any of a number of alarm or defect conditions. Such defect condition may occur when the operating voltage falls below a desirable minimum voltage, or when an operator seeks access to the data terminal 176 in a manner which may cause an inadvertent power failure.

Referring specifically to FIG. 21, hardware activity may activate the data terminal 176, for example, by an operator "turning on" the data terminal 176. When a "CTS" (clear to send) signal goes from low to high, power is applied and the microprocessors 288 and 261 may be reset. At that time the software or the control functions of the data terminal 176 take over. The voltage is checked and would be compared to a preset minimum (or even maximum) voltage. If the voltage check is "OK", a memory check is performed. If the memory check is passed, all states of the data terminal 176 prior to shut down are restored ("RESTORE STATE"). Thus, whatever operation may have been performed prior to shutdown, the data terminal 176 becomes enabled to resume that operation. Thus, unless other operations are

initiated, the ("RESUME") step is executed. If a memory check was failed, a full reset will be performed.

Further in reference to FIG. 21, a timed activity monitoring function may be executed by the maintenance processor 288 (see FIG. 19). For example, if there is no activity within ten seconds, the states of the data terminal 176 are again saved, as well as memory and data states, and the data terminal is powered down, at which all software functions necessarily stop because of lack of power. It now again takes mechanical or hardware action, as explained, to again power up the data terminal 176. However, because all states are saved, operation of the data terminal 176 is resumed at the point of operation at which power down operation was initiated.

If there is system activity, or if there has been system activity within a preset monitoring period, such as the ten second period, the data terminal 176 will continue to perform its tasks. Voltage levels are polled in preferred intervals. A preferred interval is once every millisecond or 1000 times per second. This polling activity is an activity performed by the maintenance microprocessor 288. As soon as a low voltage condition is detected, the shut down sequence is initiated. The active states are saved to shadow ram, and the data terminal is powered down by removing power. Further activity stops, but the most recent active states of all devices including the I/O states, are preserved. Thus, when an operator pushes a designated keyboard function switch, for example, the operation of the data terminal 176 may be resumed.

FIGS. 22, 23 and 24 show a modification to and an alternate embodiment of the data terminal 176 as shown in FIGS. 12 and 13 for example. At

the end 184, which is also an upper end of the data terminal 176, the handstrap 314 may be opened to obtain access to quarter turn fasteners 390, 391. An endcap 392 may then be removed. A safety switch 393 signals an impending opening and removal of the endcap 392. The removal of the endcap 392 permits access to the battery compartment 394 as well as to the PCMCIA slots 333 and 334 associated with the PCMCIA connectors 330 and 331. The switch 276 is shown disposed adjacent the slot 333 with a mechanical link 398 sensing the presence of a special card. It is to be noted that with an access provided to the battery compartment 394, a similar access to the battery, such as the battery compartment door 242 shown in FIG. 12 may be eliminated. The opposite end of the data terminal may therefore be dedicated to the external and pin connectors 235 and 347. It is to be understood, that any of these features may be modified or even omitted without departing from the overall objects and the scope of the invention.

FIGS. 25 through 28 show, for example, features of the data terminal 175, and particularly the data terminal 176, which are deemed advantageous in accordance herewith. Instead of the previously described digitizing array 179, FIG. 25 shows the data terminal 176 with the touchpad 32. For simplicity, the keys 194 of the keyboard 191 carry their respective indicia. The cursor key cluster 195 is prominently located adjacent a right hand side of the data terminal 176. As previously described, the keyboard 191 is preferably operable in parallel with the touch sensitive array 32 or touchpad 32. Thus, an operator may graphically record data via the touchpad 32. If for any reason the touchpad should not be operable, an

operator may switch data input operations without interruption to enter data via the keyboard 191.

Referring to a preferred modification of the data terminal 176, as illustrated by the bottom view shown in FIG. 26, there is shown a bottom surface contact pad, designated generally by the numeral 400. The surface contact pad 400 features a bottom row of lower surface contacts 401 and a top row of upper surface contacts 402. The upper surface contacts 402 are laterally or transversely staggered with respect to the lower surface contacts 401, such that a mating contact aligned with one of the upper contact pads 402 would slide between respective ones of the lower surface contacts or lower contact pads 401, when the data terminal 176 is inserted into a docking cradle 236, as shown in FIG. 13. Ridges 403 may be disposed between adjacent ones of the lower contact pads 401, to even lift any such sliding, mating contact over the first or lower row of the lower contact pads 401. Sliding contacts which mate with the lower contact pads 401 may then actually be guided by such adjacent intervening ridges 403. The handstrap 311 may be attached at the lower end of the data terminal 176 by such surface contact pad 400.

Referring now to the diagram of FIG. 27, is will be realized that some modifications have been made, which modifications are considered improvements of the described embodiments of the invention, and without departing from the spirit and scope thereof. The numerals shown, for example, in the diagram of FIG. 19 are retained with respect to the same or comparable components or functions, simplifying pointing to advantageous changes shown in FIG. 27. Simplifications include a deletion of an optional ROM 378 described with respect to FIG. 19. Also, a memory refresh

operation 329 may be advantageously executed by the SCAMP device 267 amd is not separately shown. An advantageous change provides for the VGA Controller device 296 to be addressed directly by the applications microprocessor 261, rather than through the SCAMP device 267, as shown by the routing of the address and data buses 262 and 263, respectively.

The communications interface device 287 is linked directly with address, data and control buses to both the applications microprocessor 261 and the maintenance microprocessor 288. A control bus 406 couples the communications interface device 287 and the SCAMP device 267. A control bus 407 couples the communications interface device 287 to the VGA controller 296. A further modification relates to the switch 276 which no longer interacts with a memory card as previously described, though such an interaction is considered to be an option. Instead, the switch may now be operated manually in conjunction with an ON/OFF switch of the data terminal 176, when a special memory card is present and the memory address function is to be altered as previously described. Inasmuch as the array 179 has been replaced with the touchpad 32 as an overlay over the LCD screen 180, the digitizer circuit 294 is shown displaced by an analog to digital signal converter 408 (A/D CONV). A touch screen control line 409 leads to the converter 408, and digital signals are obtained via the data bus 410, as obtained from an analog voltage output via line 411 from the touchpad 32.

FIG. 28 shows preferred functions of the communications interface circuit 287. The respective address, data and control buses from the microprocessors 261 and 288 lead into a processor interface and contention resolution

circuit 415. From the interface 415, an address bus 416 and a data bus 417 provide for selective addressing and operation of an A/D converter function 418, a sleep mode function 419, the control 420 of interaction between the applications and maintenance microprocessors, the maintenance microprocessor interrupt control 421 and a general system control function 422 which addresses and operates the various other functions as herein before described, and through which status data may be received via status bus 423. The communications interface circuit is further improved with a maintenance processor master mode function 425. The master mode function 425 may be triggered by a float signal line signal at 426 originating from the applications processor 261, indicating that the applications microprocessor is not functioning. Such malfunction may, for example, occur when the BIOS program residing in the flash memory device 266 (FIG. 27) has become defective. When such a malfunction occurs which blocks the operation of the data terminal 176, the master mode function 425 converts address, data and control functions of the maintenance microprocessor 288 to the output format of the applications microprocessor 261, thereby permitting the data terminal 176 to operate under the sole control of the maintenance microprocessor, though at the slower speed of the microprocessor.

In view of the above detailed description of a preferred embodiment and modifications thereof, various other modifications will now become apparent to those skilled in the art. The claims below encompass the disclosed embodiments and all reasonable modifications and variations without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. Portable data collection apparatus comprising:

a housing having front and rear housing surfaces;

a display screen disposed at the front housing surface and including an active area for displaying data in a first orientation with respect to the housing;

a keyboard disposed in the front housing surface, the keyboard having a base surface and a plurality of keys arranged in an array within the confines of the base surface, each of the keys having an assigned function corresponding to a predetermined signal applied within the apparatus in response to a depression of the respective key, the assigned functions forming a pattern of functions with respect to the housing; and

means for changing the orientation with respect to the housing, of data displayed in the active area of the display screen from the first orientation to another orientation.

2. Apparatus according to claim 1, wherein at least some of the keys are numerical keys, and the assigned functions of the numerical keys comprise numerical input functions for applying numerical input signals to the apparatus, and wherein the apparatus further comprises means for changing the assigned functions of at least some of the numerical keys to reorient the assigned key functions in accordance with the changed orientation of the data displayed in the active area of the display screen, the reassigned function maintaining a numerical input key pattern from the first orientation.

3. Apparatus according to claim 1, wherein the display screen comprises a touch sensitive overlay covering at least a portion of the active display area of the display screen, means defining within the area of the overlay an array of discrete touch sensitive key areas, each of the key areas having a predetermined function for generating a predetermined input signal to the apparatus, and means for selectively identifying the predetermined functions by a set of indicia displayed on the display screen, the indicia of such set being oriented in accordance with the orientation of data displayed on the display screen.

4. Apparatus according to claim 1, wherein the keyboard comprises a removably attachable template having at least one set of indicia for identifying the function of each of the keys of the array, the template set of indicia having an orientation corresponding to the orientation of the data displayed on the display screen, the template having means for becoming attached to the keyboard in one of a number of orientations to display the template set of indicia in accordance with the then current orientation of the data displayed on the display screen.

5. Apparatus according to claim 4, wherein the means for changing the orientation with respect to the housing, of data displayed in the active area of the display screen from the first orientation to another orientation comprises sensor means for sensing the orientation of the indicia of the template set of indicia with respect to the housing, and means for reorienting displayed data and assigned functions of selected

ones of the keys in accordance with the sensed orientation of the template.

6. Apparatus according to claim 5, wherein at least some of the keys are numerical keys, and the assigned functions of the numerical keys comprise numerical input functions for applying numerical input signals to the apparatus, the reoriented assigned functions maintaining a numerical input key pattern from the first orientation.

7. Apparatus according to claim 5, wherein the display screen comprises a touch sensitive overlay covering at least a portion of the active display area of the display screen, means defining within the area of the overlay an array of discrete touch sensitive key areas, each key area having a predetermined function for imparting a predetermined input signal to the apparatus, and means for identifying the functions by a second set of indicia displayed on the display screen, the displayed second set of indicia having the same orientation as any data displayed on the display screen.

8. Apparatus according to claim 5, wherein the template has first and second major surfaces and includes first and second sets of indicia disposed on the opposite major surfaces respectively, the first and second sets of indicia being oriented orthogonally with respect to each other, the first set of indicia oriented for identifying the functions of the keys when the displayed lines of data are non-intersecting with the keyboard and the second set of indicia oriented for identifying functions of the keys

when the lines of displayed data are coextensive with the keyboard.

9. A portable data collection terminal comprising:

a housing including a display screen and a keyboard disposed in a frontal side of the housing;

the display screen including graphic data input means disposed coincident with a screen area of the display screen; and

a power management circuit means including means for saving electrical states, including input and output device states to non-volatile memory.

10. The portable data collection terminal according to claim 9, wherein the means for saving electrical input and output states to non-volatile memory includes means for trapping input-output instructions and to shadow write such trapped input-output instructions to non-volatile memory during normal operations of the portable data collection apparatus.

11. The portable data collection terminal according to claim 9, comprising further an accessory panel including a handgrip extension pod for holding a selected accessory device of the data collection terminal, the handgrip accessory pod having a width less than the width of the data collection terminal and being disposed on an underside of the data collection terminal and beneath the frontal side of the data collection terminal, whereby the screen is protected from accidental contact by a user when holding onto the handgrip extension pod.

12. The portable data collection terminal according to claim 11, wherein the accessory device is a scanner.

13. The portable data collection terminal according to claim 9, further including a pen gripping holder molded into an end of the data collection terminal.

14. The portable data collection terminal according to claim 9, further including a memory card door having a seal and means for signaling movement of the memory card door from a locked position.

15. The portable data collection terminal according to claim 9, further including co-molded shock protection.

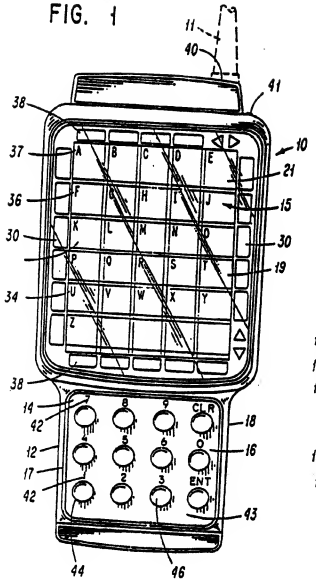
16. The portable data collection terminal according to claim 9, wherein the keyboard in parallel with the graphic data input means, the keyboard and the graphic data input means operating independently of each other with separate interrupt signals, such that operation may instantaneously switch from one to the other.

17. The portable data collection terminal according to claim 16, comprising further an accessory panel including a handgrip extension pod for holding a selected accessory device of the data collection terminal, the handgrip accessory pod having a width less than the width of the data collection terminal and being disposed on an underside of the data collection terminal and beneath the frontal side of the data collection terminal, whereby the screen is protected from

accidental contact by a user when holding onto the handgrip extension pod.

18. The portable data collection terminal according to claim 16, wherein the graphic data input means is a touch sensitive screen.

FIG. 1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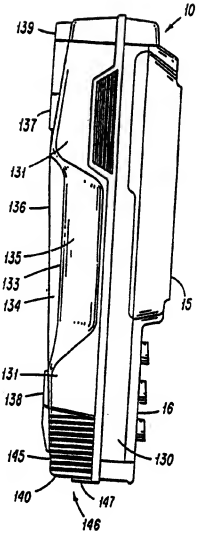
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FIG. 6

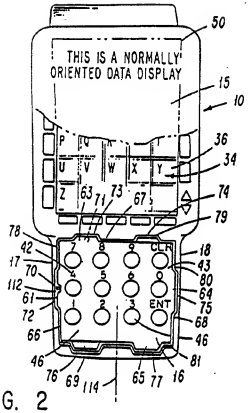


FIG. 2

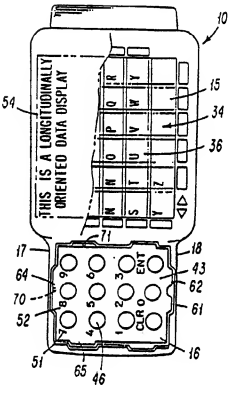


FIG. 3

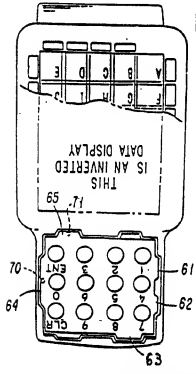


FIG. 5

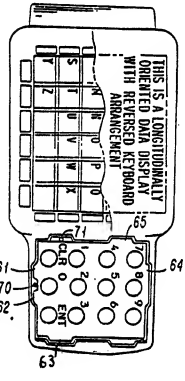
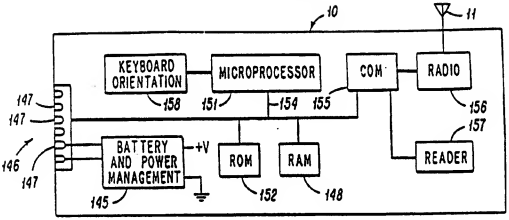


FIG. 4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11
KEYBOARD ORIENTATION
MICROPROCESSOR
COM
RADIO
158
151
154
155
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146
147
BATTERY AND POWER MANAGEMENT
+V
ROM
RAM
READER
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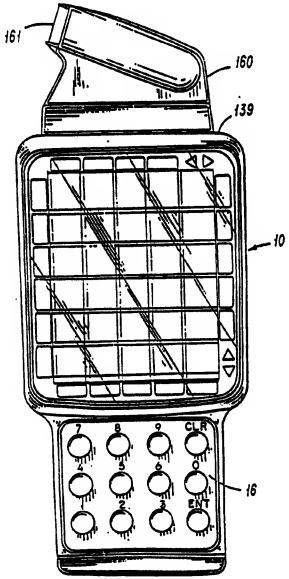
152
148

FIG. 7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CLR
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ENT

FIG. 8

FIG. 9

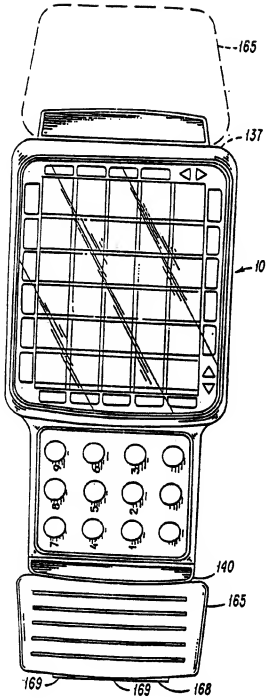
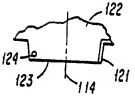


FIG. 10



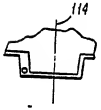


FIG. 11

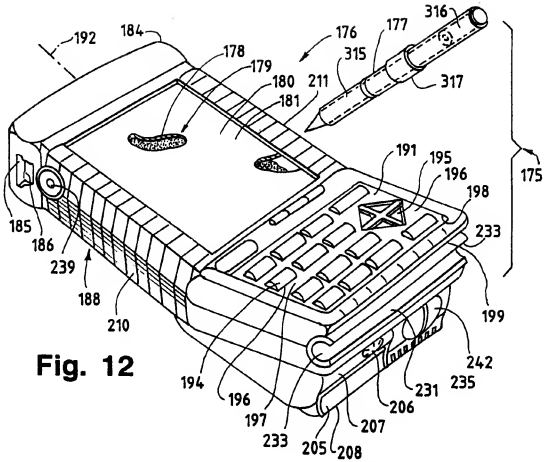

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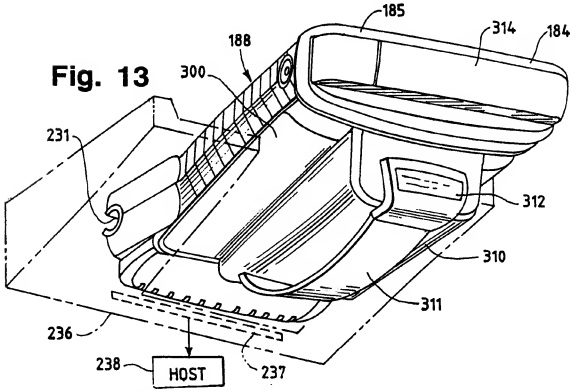
Fig. 12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HOST
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Fig. 13

Fig. 15

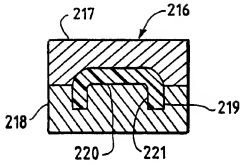


Fig. 16

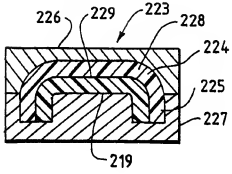


Fig. 14

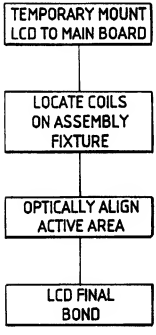


Fig. 17

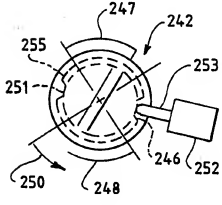
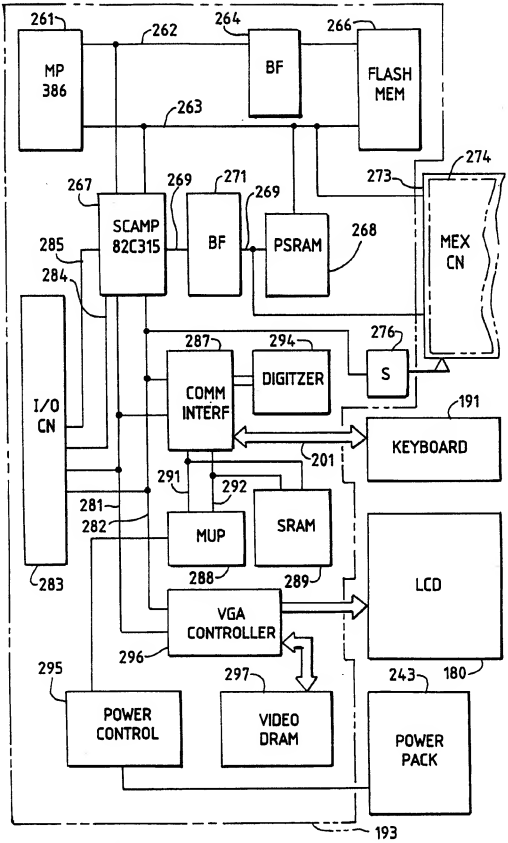


Fig. 18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MEX CN
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I/O CN
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COMM INTERF
DIGITZER
S
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KEYBOARD
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MUP
SRAM
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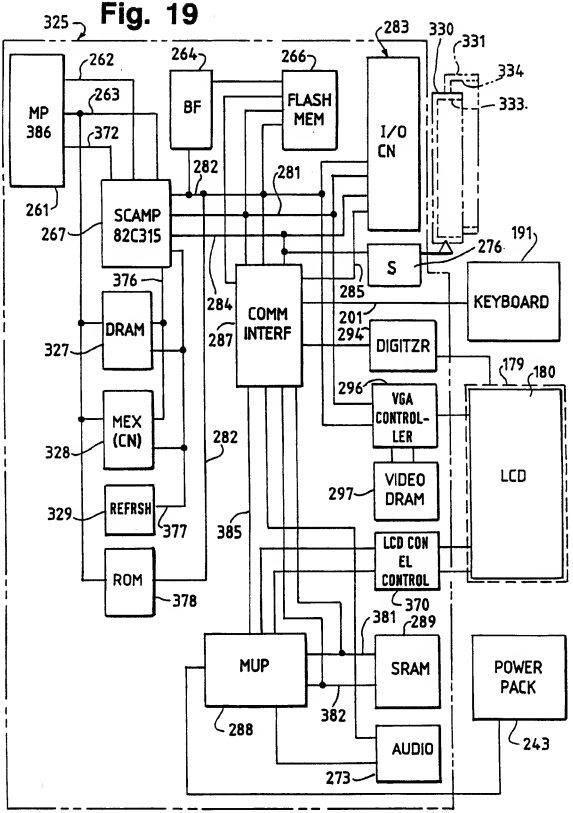
POWER CONTROL
VIDEO DRAM
POWER PACK
193

Fig. 19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KEYBOARD
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DRAM
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MEX (CN)
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VGA CONTROL-LER
LCD
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VIDEO DRAM
REFRSH
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POWER PACK
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AUDIO
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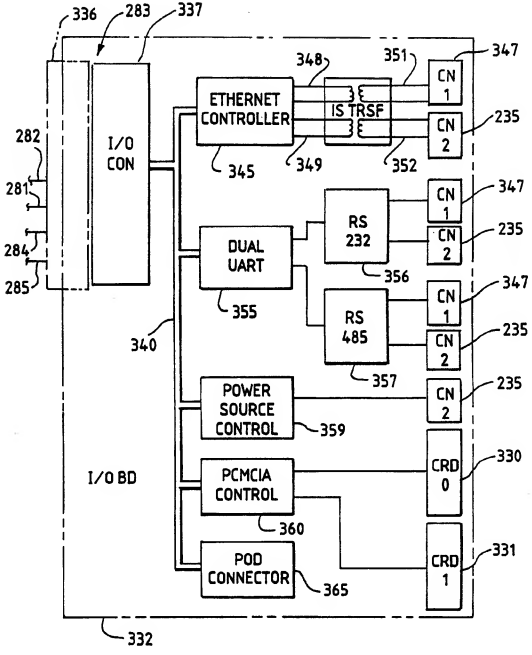
Fig. 20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ETHERNET CONTROLLER
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CN 2
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RS 232
DUAL UART
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RS 485
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POWER SOURCE CONTROL
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PCMCIA CONTROL
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POD CONNECTOR
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CRD 1
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Fig. 21

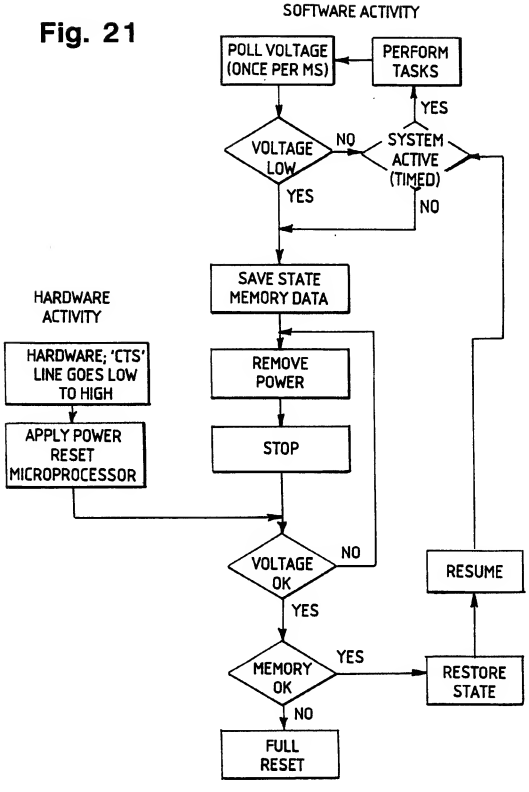

SOFTWARE ACTIVITY
POLL VOLTAGE (ONCE PER MS)
PERFORM TASKS
YES
VOLTAGE LOW
NO
SYSTEM ACTIVE (TIMED)
YES
NO
SAVE STATE MEMORY DATA
HARDWARE ACTIVITY
HARDWARE; 'CTS' LINE GOES LOW TO HIGH
REMOVE POWER
APPLY POWER RESET MICROPROCESSOR
STOP
VOLTAGE OK
NO
RESUME
YES
MEMORY OK
YES
RESTORE STATE
NO
FULL RESET

Fig. 22

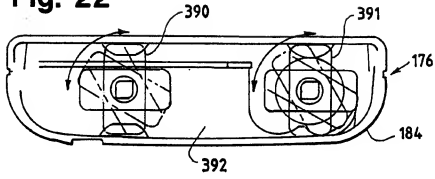


Fig. 23

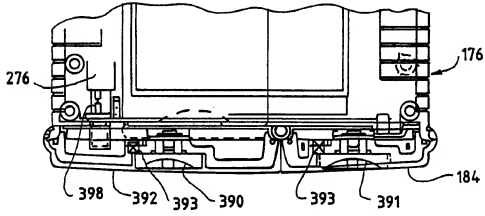


Fig. 24

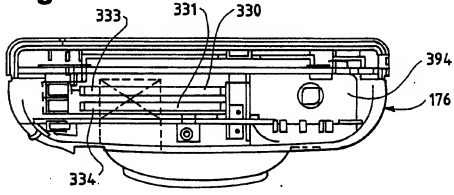


Fig. 25

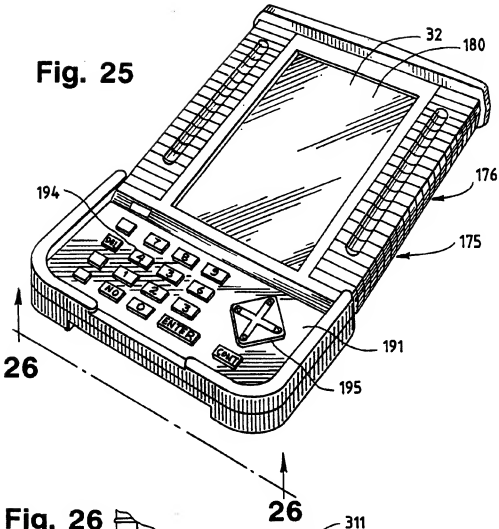


Fig. 26

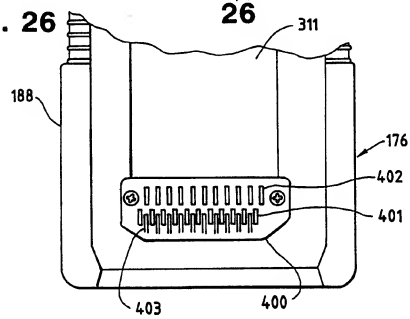
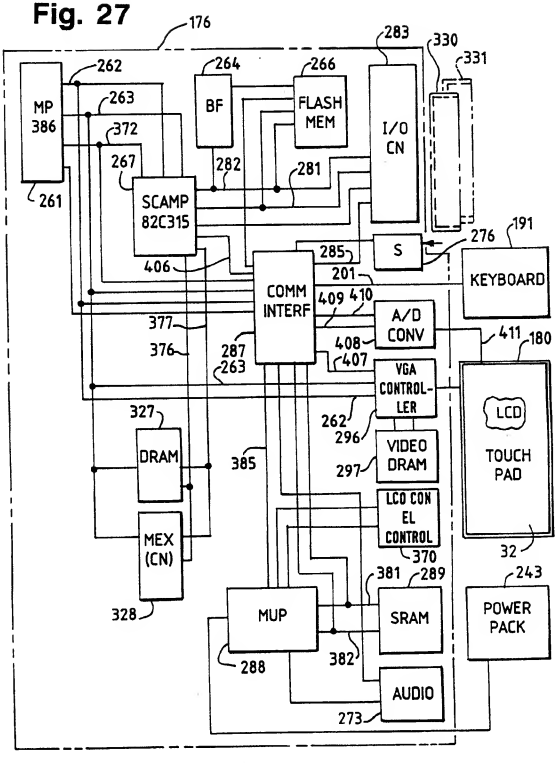


Fig. 27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KEYBOARD
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VGA CONTROL-LER
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VIDEO DRAM
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AUDIO
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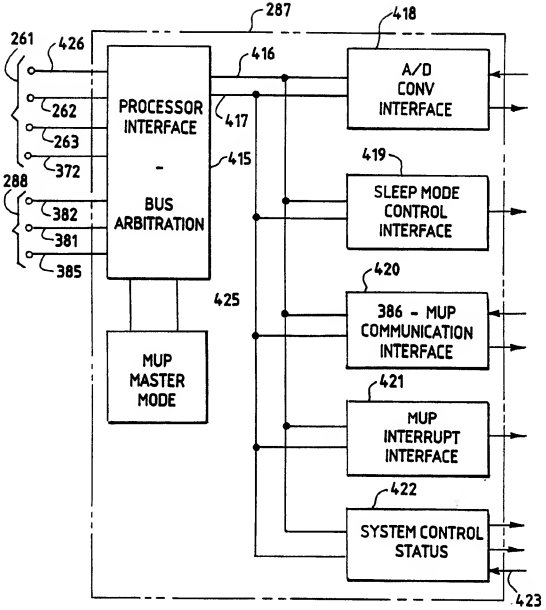
Fig. 28


287
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PROCESSOR INTERFACE
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A/D CONV INTERFACE
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SLEEP MODE CONTROL INTERFACE
288
382
381
385
BUS ARBITRATION
420
386 - MUP COMMUNICATION INTERFACE
425
MUP MASTER MODE
421
MUP INTERRUPT INTERFACE
422
SYSTEM CONTROL STATUS
423

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/02091

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :G06F 1/32, G06F 3/00;
US CL :364/707, 710.01;
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Please See Extra Sheet.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 5,109,354 (YAMASHITA et al) 28 APRIL 1992, Figs. 12a, 12b, and 13; col. 2, lines 2-5 and col. 5, lines 20-32	1-3 ----- 4-8
Y	US, A, 4,279,021 (SEE et al) 14 JULY 1981, ABSTRACT	4-8
Y, P ----- X, P	US, A, 5,241,680 (COLE et al) 31 AUGUST 1993, ABSTRACT	9-10, 16, 18 ---------- 11-15, 17
Y	US, A, 4,916,441 (GUMBRICH) 10 APRIL 1990, ABSTRACT	11-12, 17
Y	US, A, 4,075,702 (DAVIES) 21 FEBRUARY 1978, col. 4, lines 28-31	13

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 June 1994	27 JUL 1994
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer DAVID H. MALZAHN
Facsimile No. NOT APPLICABLE	Telephone No. (703) 305-3800

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/02091

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,155,659 (KUNERT) 13 OCTOBER 1992, ABSTRACT	14
Y	US, A, 4,703,161 (MCLEAN) 27 OCTOBER 1987, ABSTRACT	15
A	US, A, 5,103,376 (BLONDER) 07 APRIL 1992, ENTIRE DOCUMENT	1-8
A	US, A, 5,144,302 (CARTER et al) 01 SEPTEMBER 1992, ENTIRE DOCUMENT	1-8
A,P	US, A, 5,268,817 (MIYAGAWA et al) 07 DECEMBER 1993, ENTIRE DOCUMENT	1-8
A,P	US, A, 5,203,003 (DONNER) 13 APRIL 1993, ENTIRE DOCUMENT	9-18
A	US, A, 5,133,076 (HAWKINS et al) 21 JULY 1992 entire document	9-18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/02091

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Group I Claims 1-8 drawn to a data display arrangement classified in class 364, subclass 710-01.
Group II Claims 9-18 drawn to a power savings arrangement classified in class 364, subclass 707.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.
☒ No protest accompanied the payment of additional search fees.

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

364/707, 710.01;
364/708.1, 709.1, 709.11;